Engineering Library

AUTOMOTIVE INDUSTRIES

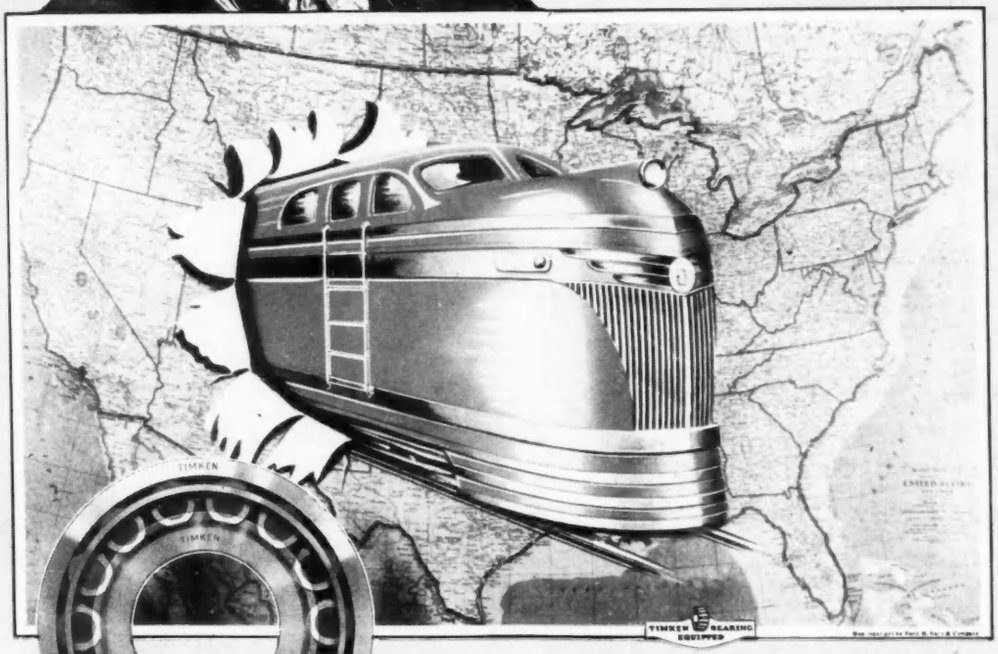
LAND — AIR — WATER

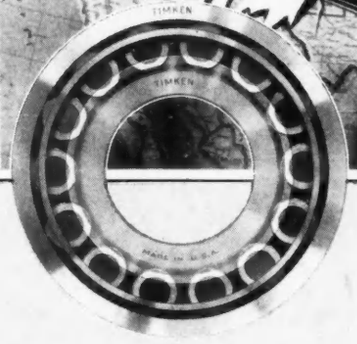
JAN 17 1941

JANUARY 15, 1941

MILES of SMILES
on Timken Bearings

Practically all of the great modern Streamliners are Timken Bearing Equipped. This assures the highest degree of riding comfort. What railroad men like is the fact that Timken Bearings increase the efficiency of locomotives, passenger and freight cars—cut operating costs—eliminate hot-boxes. ¶Back of the Timken Roller Bearing is a wealth of research, engineering knowledge, and over forty years of vast experimental work. ¶If you would enjoy the utmost comfort—Miles of Smiles when you travel—take a Timken Bearing Equipped train. The Timken Roller Bearing Company, Canton, Ohio.





TIMKEN
TAPERED ROLLER BEARINGS

NOTICE—Look for the trade-mark TIMKEN on every bearing, whether buying new equipment or replacing a Timken Bearing in your automobile or truck, industrial or farm machinery. That trade-mark is your assurance of quality.

This advertisement appeared in the December 28 issue of THE SATURDAY EVENING POST and in current issues of other leading magazines.

BORIZING

What it is and What it does

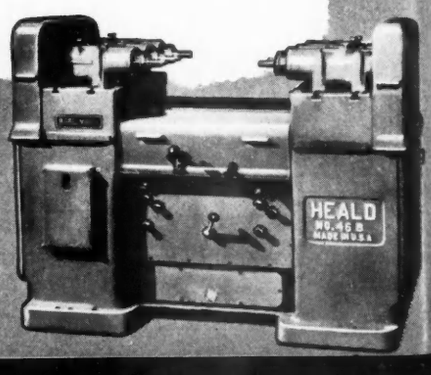
Borizing or precision finishing is a high-accuracy machining process which has generally replaced boring, reaming, facing, turning, milling and often times grinding wherever extreme precision is required. By this method accuracy can be maintained in production to .0002″ and closer for size, roundness and straightness, finish as close as 8 micro inches. Borizing assures consistent duplication of accuracy with minimum scrap and rejections without penalizing production, which is maintained at rates equal to and in most cases better than other methods.

To handle the borizing process, special machines such as Heald Bore-Matics have been developed. These machines use tools tipped with tungsten carbide (sometimes diamond) which is outstanding in its ability to maintain a cutting edge over long runs. In conjunction with tungsten carbide cutting materials borizing machines employ single-point tools, high surface speeds, and relatively light cuts, these factors making possible improved finish and accuracy through reduced feed lines and tool pressure.

The last degree of precision possible from this process is insured by many invaluable features which have been incorporated in the design of Heald Bore-Matics. In Bore-Matics you'll find extremely rigid construction throughout, velvet-smooth hydraulic table control, force feed lubrication to table ways, ample flat and V ways for stabilized table travel, smooth, powerful V belt drive to boring heads, super-precision bearings with automatic preloading in boring heads — in fact, in Bore-Matics you'll find every feature for smooth vibrationless operation so essential in borizing.

Practically every type of material except hardened steel can be finished by borizing. Heald Bore-Matics will handle aluminum, brass, bronze, copper, lead, zinc, carbon, cast iron, soft steel, stainless steel, monel metal, etc. These materials can be not only precision bored on Heald Bore-Matics but also precision turned, faced, grooved and chamfered, either singly or in any combination as multiple cuts.

Many years of service in leading aircraft, electric refrigerator and automotive plants have conclusively proven the value of the borizing process and Heald Bore-Matics as a production tool.



THE HEALD MACHINE CO.
WORCESTER, MASSACHUSETTS, U. S. A.

AUTOMOTIVE INDUSTRIES
The Automobile

Reg. U. S. Pat. Off.
Published Semi-Monthly

Volume 84 Number 2

JULIAN CHASE, Directing Editor
P. M. HELDT, Engineering Editor — JOS. GESCHELIN, Detroit Technical Editor
JEROME H. FARRIS, Ass't Editor — HOWARD KOHLBRENNER, Art Editor
E. L. WARNER, JR., Detroit News Editor — L. W. MOFFETT, Washington News Editor
MARCUS AINSWORTH, Statistician — JAMES G. ELLIS, Washington News Editor

CONTENTS

New Plan for Bomber Building Centers on Automobile "Big Three." *By E. L. Warner* 57

Business in Brief 58

Honed Microfinish for Aircraft Parts. *By P. M. Heldt* 59

Plastics Used in the Fabrication of Larger Parts of Aircraft. *By Herbert Chase* 63

Aviation Discussed at the S. A. E. Annual Meeting 70

Men and Machines 72

Automotive Materials 74

New Car and Truck Registrations 79

New International Heavy-Duty Truck Models 80

SAE Annual Meeting 82

News of the Industry 87

Calendar of Coming Events 89

Advertisers Index 80

Copyright 1941 by Chilton Company (Inc.)

Automotive Division
Jos. S. Hildreth, President and Manager
Julian Chase, Vice Pres. G. C. Buzby, Vice Pres.

OFFICES

Philadelphia—Chestnut & 56th Sts., Phone Sherwood 1424
New York—100 East 42nd St., Phone Murray Hill 5-8600. Chicago—Room 916 London Guarantee & Accident Bldg., Phone Franklin 4243. Detroit—1015 Stephenson Bldg., Phone Madison 2090. Cleveland—609 Guardian Bldg., Phone Cherry 4188. Washington—1061 National Press Bldg., Phone District 6877. San Francisco—444 Market St., Room 305, Phone Garfield 1721. Los Angeles—6000 Miramonte Blvd., Phone Lafayette 5525. Long Beach, Cal.—1595 Pacific Ave., Phone Long Beach 613-238.
Cable Address .....Autoland, Philadelphia

Member of the Audit Bureau of Circulations
Member Associated Business Papers, Inc.

Automotive Industries—The Automobile is a consolidation of the Automobile (monthly) and the Motor Review (weekly), May, 1902; Dealer and Repairman (monthly), October, 1903; the Automobile Magazine (monthly), July, 1907, and the Horseless Age (weekly), founded in 1895, May, 1918.

Owned and Published by
CHILTON COMPANY
(Incorporated)

Executive Offices
Chestnut and 56th Streets, Philadelphia, Pa., U. S. A.

Officers and Directors
C. A. MUSSELMAN, *President*
Vice-Presidents
JOS. S. HILDRETH — GEORGE H. GRIFFITHS
EVERIT B. TERHUNE — J. H. VAN DEVENTER
C. S. BAUR
WILLIAM A. BARBER, *Treasurer* — JOHN BLAIR MOFFETT, *Secretary*
JULIAN CHASE — THOMAS L. KANE — G. C. BUZBY
P. M. FAHRENDORF — HARRY V. DUFFY — CHARLES J. HEALE

● 37 other gems had an equal chance of being named . . . yet it's a one to two bet that you said "Diamond." That's what popularity does!

It works the same way for clutches, too . . . you'll hear "Borg and Beck" most often when you ask your automobile colleagues to sing out the first clutch name they think of.

Borg and Beck clutches earned this distinction (and incidentally the lion's share of the industry's orders) by delivering an honest dollar's worth of service and long life for every dollar they cost . . . by living up to the reputation that they can be "installed, then forgotten." They maintain their steady flow toward the industry's assembly lines because Borg and Beck engineers have the fortunate ability to look and plan ahead, and produce on time.

If you need more clutches today—or a new clutch tomorrow—you can count on this—Borg and Beck will do right by you. It costs nothing to make us prove it.

Borg & Beck, the No. 1 clutch, is installed as original equipment in 36 motor cars, trucks, buses and tractors. It is built by Borg & Beck Division of Borg-Warner Corporation in Chicago.

AUTOMOTIVE INDUSTRIES, Vol. 84, No. 2. Published semi-monthly by Chilton Co., Chestnut & 56th Sts., Phila. Entered as Second-Class Matter October 1, 1925, at the Post Office at Philadelphia, Pa.; Under the Act of Congress of March 3, 1879. In Case of Non-Delivery Return Postage Guaranteed. Subscription price: United States, Mexico, United States Possessions, and all Latin-American countries, $1.00 per year. Canadian and Foreign, $2.00 per year; single copies, 25 cents, except Statistical Issue (Mar. 1, 1941), 50 cents.

Why "LUCITE" dresses up the new Packard!

TODAY'S discriminating car buyers open their eyes wide when they see the new Packard. Inside and out, it's the kind of car you dream of. And appointments of "Lucite" methyl methacrylate molding powder are large contributors to this eye-filling beauty. The man who *makes* the new Packards will give you a lot of reasons why!

"We wanted a material for exterior use that would keep its beauty in any weather!" And so the gleaming transparent fin on the Packard radiator ornament was molded of "Lucite." Wind, rain, snow or blazing sunlight won't dull its brilliant clarity . . . for actual exposure tests have proved its remarkable weather resistance.

"We wanted a material that would enable us to illuminate our dashboards strikingly . . . and economically!" Again, they selected "Lucite," because it has the ability to pick up light and "pipe" it to any desired spot. On the new Packard, molded parts of clear "Lucite" form speedometer panels, pointers and clock dials. When you snap on the dash light the numerals etched on these panels jump right out of the darkness in a brilliant glow of light!

"We wanted a material that would be tough and strong . . . yet would lend itself easily to decorative treatment!" Once more, "Lucite"—for the smooth, hard horn-button covering. This sturdy covering will stand a lot of horn-punching without losing its pleasing lustre. Packard's attractive emblem is painted on the reverse side . . . and shines brightly through the transparent "Lucite."

For long-wearing, functional beauty, designers and engineers of at least fourteen leading makes this year choose "Lucite." We invite you to try this remarkable material . . . as well as the other famous plastics made by Du Pont. And if you have a plastic problem, the Du Pont technical service is ready to help you solve it. Write to E. I. du Pont de Nemours & Co. (Inc.), Plastics Dept., Arlington, N. J.

"Lucite" is Reg. U. S. Pat. Off.

DU PONT

PLASTICS

IN THIS ISSUE . . .

AUTOMOTIVE INDUSTRIES

Reg. U. S. Pat. Off.

Volume 84 January 15, 1941 Number 2

Substitute Fuels Greatly increased use of wood and charcoal as a motor vehicle fuel in Germany and of ordinary lighting gas for the same purpose in Belgium are indicated in reports received recently by the Department of Commerce.

According to the Motor Fuel Wood & Waste Utilization of Berlin, a private enterprise operating under strict government supervision, approximately a million cubic meters of motor fuel wood will be distributed during the fiscal year ending Sept. 30, 1941. The necessary raw material will be obtained by requiring quotas of firewood to be delivered by owners of timber lands and quotas of mill waste by the woodworking industries. Many motor fuel wood stations will be established, all of which will be within twenty-five kilometers from the sources of raw materials. Each depot will be able to store from 3000 to 15,000 cubic meters of fuel wood. The mincing or chopping of the raw materials into "generator size" is being done by newly developed "mincing rotors" equipped with automatic feeders. The company plans to equip their principal depots with special loaders and round storage bins, and also some of them with kilns.

The equipment required for utilizing gas as a vehicle fuel, says the Antwerp Gas Co., can be installed on any vehicle now using gasoline for fuel. The apparatus consists of a special attachment to the carburetor and three or more gas cylinders at a pressure of 350 kilograms (770 lb.) installed on the roof or running board.

The equipment, which is manufactured in Belgium, will cost about 10,000 Belgian francs ($300) installed, but a saving of 37.5 per cent in fuel cost will be realized. Furthermore, the tax on such gas-operated vehicles will only be one-tenth of the normal tax and no permit to drive, such as is now required for all gasoline and oil driven vehicles, will be necessary.

German authorities are said to be encouraging the movement, as it will leave available a larger supply of gasoline for military purposes. It is estimated that not more than 10 per cent of the gasoline vehicles now registered in Belgium are allowed to circulate.

GENERAL

Page

New Plan for Bomber Building **57**

New developments are taking place in the National Defense program. In this article the distribution of responsibility among the "Big Three" automobile manufacturers is explained in detail. Just what they will do to bring the country up to a full stage of preparedness is a big step in the coordination of industries.

AERO DESIGN

AVIATION INDUSTRIES SECTION

This section brings you right up to the minute on the all-important aircraft industry, not alone in what is happening but how these things are being accomplished.

Honed Microfinish for Aircraft Parts **59**

Production methods are the keystone of accomplishment in the revised program of producing airplanes in much greater numbers than ever before. Here is shown how the technique of Microfinish helps.

Plastics Used in the Fabrication of Aircraft **63**

In recent years a new material has entered the production picture but only recently has it become a dominant factor in the airplane field. What is being done in this respect and how large a factor it is becoming is told here.

Aviation Discussed at the S.A.E. Annual Meeting **70**

The S.A.E. has just completed its annual meeting in Detroit. Much was said and done in regard to aircraft. Papers presented on this subject have been segregated and printed as a unit. They will not only inform you of what is being done but will give you a look into the future as well.

TRUCK DESIGN

International Heavy-Duty Truck Models **80**

A new line of models announced by the I. H. C. incorporates a number of new features that will be of interest to our readers.

NEW DEVELOPMENTS

S.A.E. Annual Meeting **82**

At the annual meeting of the S.A.E., papers covering a wide variety of new developments in engineering were presented. Here a number of them have been abstracted for your convenience. There are more to come in subsequent issues.

Business in Brief 58 **Automotive Materials 74**

Men and Machines 72 **News of the Industry 87**

Calendar of Coming Events 89

Capt. Howard Kizer, standing near the pilot house of the ice-coated Inland freighter, the Joseph Block.

Steel Sailors Battle

THROUGH TERRIFIC STORM

The wind had risen to a 75-mile gale, 50-foot waves crashed over freighter pilot houses, and at various points on Lake Michigan, ships were being battered to destruction. Through this terrific fall storm Captain Howard Kizer, of the Inland freighter *Joseph Block*, fought his way safely to the Inland docks at Indiana Harbor.

As the ship passed Little Point Sable near Ludington, the barometer began to fall, dropping to 28.40, a very dangerous level, and the wind shifted to the south. With the waves crashing perilously over the pilot house, Captain Kizer decided that he dare not head directly into the storm and so changed his course to take the full force of the sea at about four points on his beam. Despite this precaution, waves broke through the pilot house windows, the water freezing as it fell. The whole ship was sheathed with ice.

At the height of the storm, the freighter made no headway at all, but finally reached the west shore near Milwaukee, and arrived safely at Indiana Harbor eighteen hours late.

Less than 16 hours after arrival, the *Joseph Block* was again heading north for its next load, as usual.

This is only one instance of the many hazards encountered by the steel sailors of the Inland fleet. From the spring break-up of ice in the "Soo" until ice again locks the passage, these men navigate day and night through all kinds of weather to bring great tonnages of ore, limestone and coal to the Inland Mills.

Thus, ample stocks of uniform quality raw materials are always on hand and capacity production is assured.

SHEETS · STRIP · TIN PLATE · BARS · PLATES · FLOOR PLATES · STRUCTURALS · PILING · RAILS · TRACK ACCESSORIES · REINFORCING BARS

INLAND STEEL CO.

38 S. Dearborn Street, Chicago • Sales Offices: Milwaukee, Detroit, St. Paul, St. Louis, Kansas City, Cincinnati, New York

AUTOMOTIVE INDUSTRIES

Published on the 1st and 15th of the month

Vol. 84, No. 2
January 15, 1941

New Plan for Bomber Building Centers on Automobile "Big Three"

Ford, General Motors and Chrysler to be made responsible for Production of Fuselage Parts and Sub-Assemblies

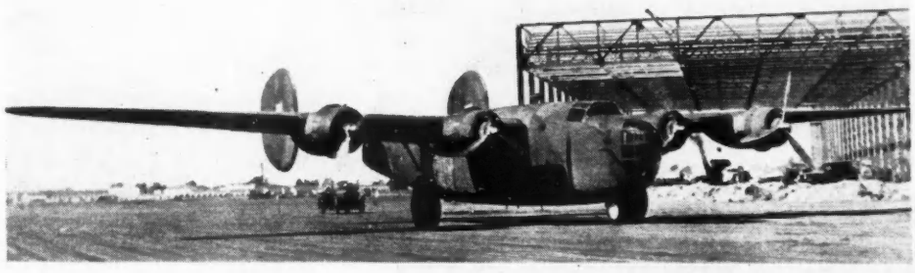
By E. L. WARNER, JR.

IN ORDER to centralize responsibility and concentrate management direction, the War Department, in conjunction with the Automotive Committee for Air Defense and the National Defense Commission, plans to make each of the three largest automobile manufacturing companies responsible for the production of the fuselage parts and sub-assemblies for one of the three types of bombing planes that will be produced for the U. S. Army. This is a variation of the original plan under which the Automotive Committee for Air Defense was to assume responsibility for the parts and sub-assemblies and then ship to the aircraft company assembly plants for putting together.

The revised plan as drawn up by the War Department calls for Ford, General Motors and Chrysler each to accept responsibility for fuselage and wing parts and sub-assemblies for one of the bombers that are to be produced in mass production quantities. The engines for these planes will be produced in other plants already built or under construction. The plan is outlined as follows:

(1) Ford would be responsible for the Consolidated B-24 four-engined bomber. Probably the most formidable bombing plane in the world, the B-24 weighs 42,000 lb. gross, can carry four tons of bombs and has a 110-ft. wing-spread. Its four 1200-hp. Pratt & Whitney engines propel it at better than 300 m.p.h. Under the plan, the Consolidated Aircraft Corp., of San Diego, Calif., would receive the primary contract from the Govern-

(*Turn to page* 68)



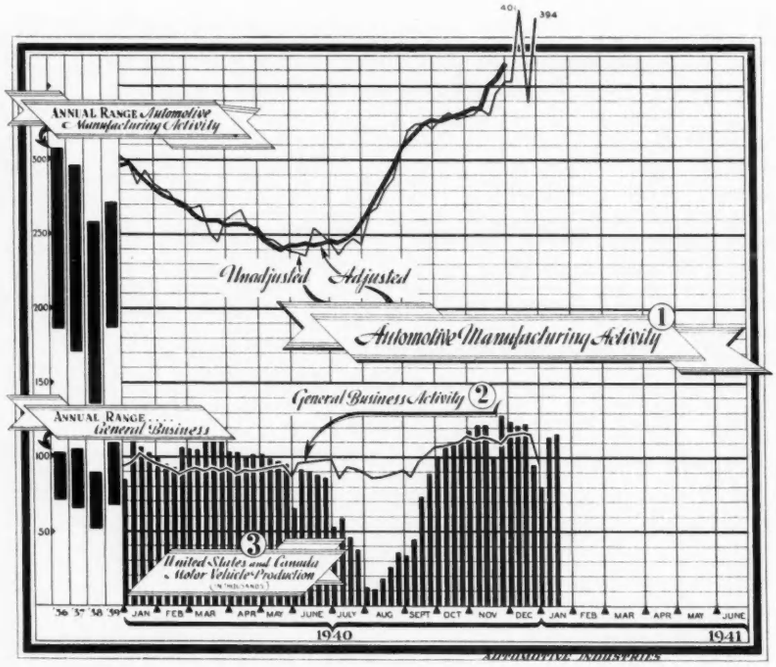
At the left is the Consolidated B24 long range bomber powered by four P&W 1200 hp. engines. It has a speed of better than 300 m.p.h. and a cruising range in excess of 3000 miles. The Ford plant has assumed responsibility for the production fuselage and wing parts to meet the new program requirements.

The wings and fuselage of the North American B25 is a General Motors responsibility. It is powered with two 18-cylinder engines of 2000 hp. each and has a speed 350 m.p.h. See page 68 for illustration of the Martin B26 in the production of which Chrysler Corp. is cooperating.

GENERAL

BUSINESS IN BRIEF

Our own view of automotive production and sales; authoritative interpretation of general conditions



Weekly indexes of automotive general business charted

Output Continues at Near-Record Level

PRODUCTION remained at near-record levels during early January with an estimated output of 215,000 motor cars and trucks during the first half of the month. This was expected to bring total production for the month close to 450,000 units, which would approximate the 449,492 vehicles turned out in January, 1940. The latter was a record for the first month of the year.

January has 22 working days, one more than December, but several plants closed down for inventory after the New Year's holiday, slightly cutting output. December's production total was estimated at 491,250 units by the Automobile Manufacturers Association.

Production climbed to an estimated 113,000 units for the week ending Jan. 11, after having dropped below the 100,000 mark in the two previous weeks due to the Christmas and New Year's holiday. General Motors turned out 51,100 vehicles, with all divisions operating on a five-day basis. Chrysler assembled 27,000 cars and trucks, while Ford manufactured 25,500 units. Packard, Hudson and Willys were the only independents in production, all operating at reduced rates, while Nash and Studebaker were down for inventory. Output was expected to increase by several thousand units in the week ending Jan. 18.

Favorable sales have prompted several manufacturers to up their first quarter schedules over those originally planned. Production in the first six months of 1941 will be boosted by deliveries of 130,000 vehicles to the U. S. Army, according to the Quartermaster General.

Although December retail sales failed to show the sensational gains over the previous year that characterized most months of 1940, modest gains of 7 to 18 per cent were reported by various manufacturers. A number of companies, however, reported the highest retail sales in their history during 1940. With three of its divisions establishing new marks, General Motors sold 1,827,241 vehicles to U. S. customers in 1940, surpassing the record of 1,720,213 units sold in 1936, and 41 per cent above 1939 sales. GM also set a new production record of 2,025,343 cars and trucks.

General Motors divisions which set new retail sales records for the year were Buick, 297,381 cars, a gain of 34 per cent over 1939; Pontiac, 239,402 cars, an increase of 45 per cent, and Oldsmobile, 204,961 vehicles, up 37 per cent. Chevrolet's retail deliveries of 1,046,069 cars and trucks were second only to 1936.

Plymouth and De Soto both established new retail sales marks, the former registering a 48 per cent gain over 1939. Ford's production of 1,005,494 units during 1940 was the greatest since 1937. Hudson retail sales gained 22 per cent in 1939.

Although dealer stocks of 283,058 passenger cars were on hand Dec. 1, the inventory situation was regarded as healthy.

[1] 1923 average = 100; [2] Prepared by Administrative and Research Corp. New York. 1926 = 100; [3] Estimated at the Detroit office of AUTOMOTIVE INDUSTRIES.

Honed Microfinish for Aircraft Parts

By P. M. HELDT

CLOSER tolerance and better mechanical finishes are required for airplane parts than for almost any other class of mechanical units, and the improved finishing processes which have been developed largely to meet requirements of the automobile industry will undoubtedly find even more extensive application, relatively at least, in the production of aircraft engines, aircraft, and parts. A high degree of accuracy is required in aircraft and engine parts in order to obtain and maintain a high specific output and a high mechanical efficiency. Moreover, the closer the tolerances and the better the resulting fits, the less will be the friction and frictional wear, and the longer the life of wearing parts. The accuracy of the fits also affects the safety of aircraft, because it reduces the chances of structural fatigue. By providing well-sealed fits in lubricated bearings, design is simplified, assembly facilitated, and service operations are rendered easier.

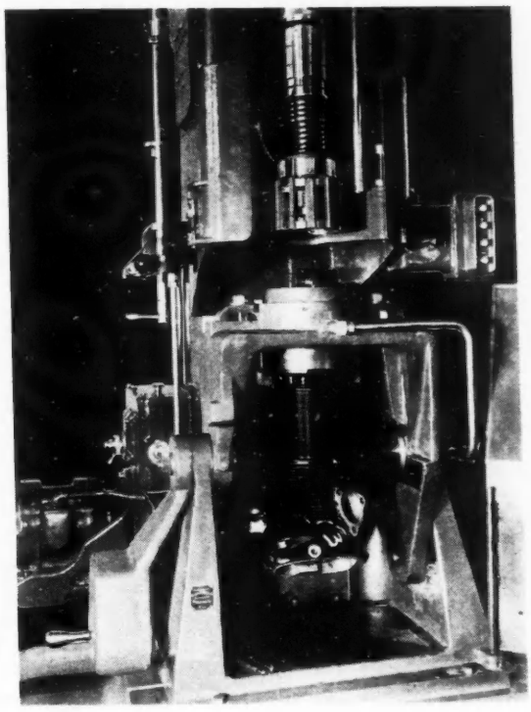


Fig. 1 — Cylinder of radial aircraft engine in honing machine

Since 1932, many aircraft and engine manufacturers have employed Microfinish honing, a process developed by Micromatic Hone Corporation of Detroit, as the final process in the production of many important parts, to meet these requirements for high accuracy.

There is perhaps no better example of the application of the Microfinish process than in finishing the bores of aircraft engines—in-line as well as radial engines. In a typical radial-engine cylinder with a hardness of approximately 350 Brinell, about 0.0015 in. stock on the diameter is removed in one operation following grinding, in approximately 7 minutes per cylinder, floor-to-floor time.

In Nitralloy barrels, with a hardness in excess of 800 Brinell, about 0.001 in. of stock on the diameter is removed in one operation, from a ground finish, in approximately 7 minutes floor-to-floor time. In both of these applications the accuracy as regards roundness and straightness is within 0.0003 and 0.0005 in. Surface irregularities are held to 1.8—2.5 micro-inches, r.m.s., Profilometer reading. Manufacturers claim that cyl-

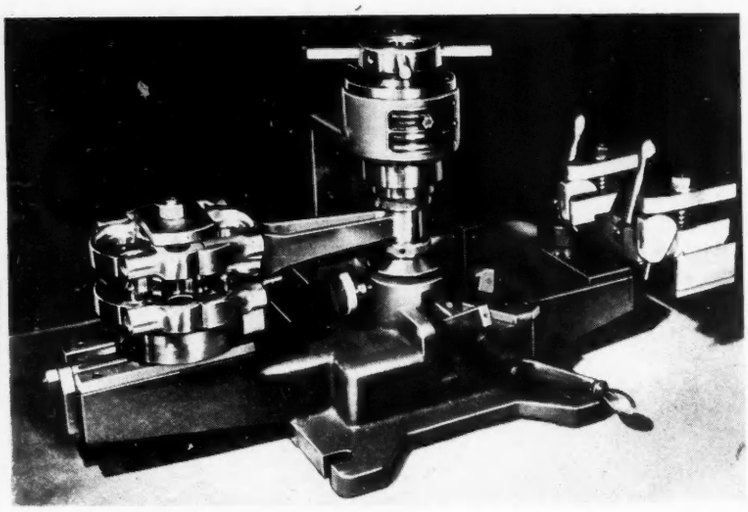


Fig. 2—Microfinishing the piston-pin hole of the connecting rod

inders with Microfinish show prolonged ring life, increased compression, minimum blow-by, and freedom from ring flutter. In Fig. 1 an air-cooled aircraft-engine cylinder is shown in the honing machine.

Exceedingly close fits are required in the crank train, and there are a number of surfaces on master connecting rods which can be finished to advantage by the Microfinish process. Fig. 2 illustrates the Microfinish operation on the piston-pin bore. This bore is finished in one operation following grinding, from 0.0005 to 0.0007 in. stock being removed in 60 seconds actual honing time. The tolerance on roundness and straightness is 0.0002 in., and surface irregularities are held to between 3 and 4 micro-inches.

Crankpin bores are micro-finished in two operations, following grinding. In the first, 0.0005 to 0.0007 in. stock is removed on the diameter, the tolerances on straightness and roundness being 0.0002 and 0.0003 in. A layer of chromium 0.0003 in. thick is then deposited on the bore, and the bores are rehoned, from 0.0003 to 0.0004 in. being removed on the diameter in 8 mins. This process gives a surface finish registering 1.7-2 micro-inches on the Profilometer, r.m.s.

Bores for link-rod pins are Microfinished in two operations. The first honing removes 0.005 in. stock from the ground finish, in 33 minutes allowed time for the eight pairs of tandem bores. All bores then have a layer of chromium, 0.0003 in. thick, deposited on them, whereupon they are rehoned. Forty minutes is the time allowed for this second honing, the stock removed being 0.0001 to 0.00015 in. on the diameter, with a tolerance on roundness and straightness of 0.0002 in. This finishing process, involving honing, plating and rehoning, is said to prevent galling and to eliminate fatigue failures in these important components.

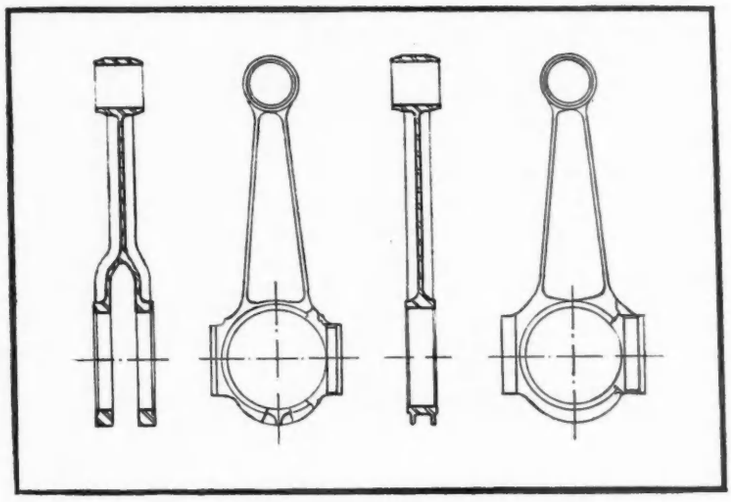
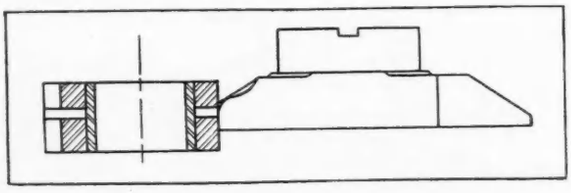


Fig. 3—Forked and blade connecting rods of V-type engines which have the bores Microfinished



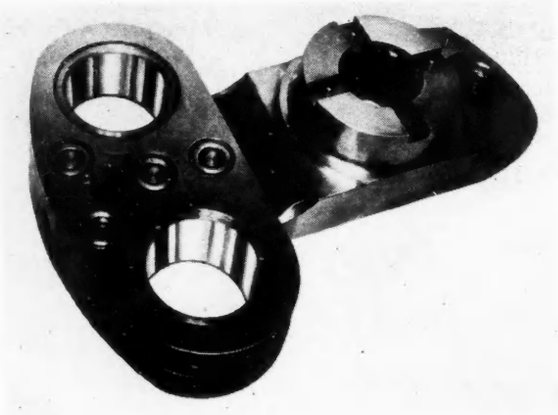


Fig. 4—Crank arm with harmonic balancer, the two large holes in which are Microfinished

Bores at both ends of the link rods are Microfinished in one operation, following grinding, about 0.0007 in. of stock being removed in about 20 seconds actual honing time for each bore. Tolerances on roundness and straightness are 0.0002 in., and the surface finish is held to 3 micro-inches r.m.s.

Connecting rods for V-type engines, referred to as forked rods and blade rods, are micro-finished in one operation, 0.0005 to 0.001 in. of stock being removed from a ground finish in from 25 to 30 seconds. The toler-

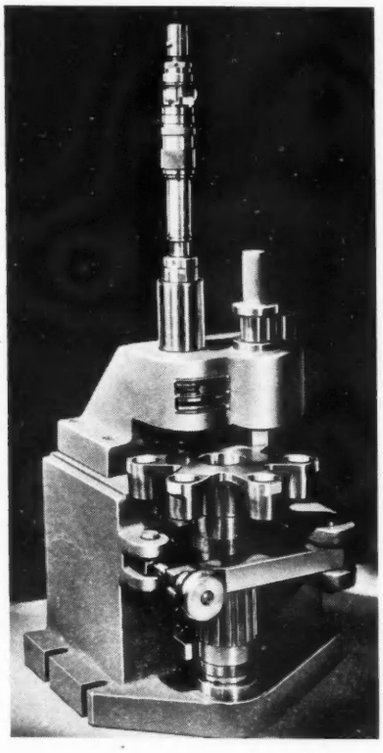


Fig. 5.—Microfinishing the bores of propeller-shaft - spider arms

A surface finish registering 5 to 8 micro-inches is obtained. This finishing operation on the bores is said to be desirable in order to remove material structurally disturbed by the boring process and to minimize the chances of fatigue failure.

Hollow camshafts are used on such engines, and the camshaft bore is Microfinished in two operations, 0.004 to 0.005 in. being removed on the diameter from a reamed bore, for clean-up and smooth surface finish, to minimize the possibility of fatigue failure.

Airplane-engine valve-tappet guides, Fig. 7, are Microfinished in one operation, following grinding. About 0.001 in. stock is removed on the diameter, in 60 seconds actual honing time, tolerances on roundness and straightness being 0.0002 in. The surface finish is held to 3 micro-inches r.m.s.

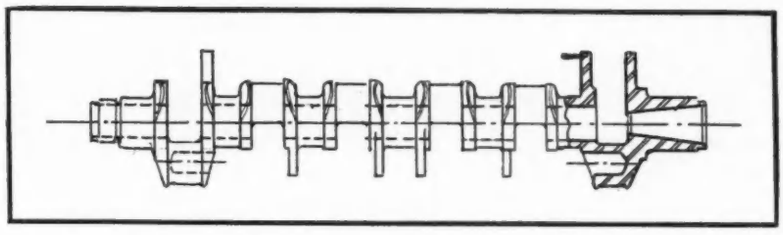


Fig. 6—Six-throw crankshaft in which the bores of main bearings and crankpins are Microfinished

ance on roundness and straightness is from 0.0002 to 0.0003 in., and the surface finish is held to 2 to 3 micro-inches, r.m.s. Drawings of the parts referred to are shown in Fig. 3.

Two bores, 2.230 in. in diameter by 2 in. long, in the crankshaft harmonic balancer are Microfinished in two operations. From 0.001 to 0.0015 in. stock is removed on the diameter, the holes being held to within 0.0002 in. as to roundness and straightness. The time allowed for honing is 3 minutes per hole, and production ranges between 8 and 10 harmonic balancers per hour. Fig. 4 illustrates the crank arm with the balancer.

Another important part to which the Microfinish honing process is applied is the propeller-shaft gear spider. This part, which is one of the elements of the planetary reduction gear, has six arms with bored bosses at the ends. All six bores are Microfinished (Fig. 5) in one operation following precision boring. Approximately 0.0012 in. of stock is removed on the diameter, in 19 minutes allowed floor-to-floor time. Tolerances for roundness and straightness are 0.0002 to 0.0003 in. These bores are honed to facilitate assembly.

All main-bearing bores and crankpin bores in the crankshafts of some in-line engines are Microfinished in one operation, following boring. Fig. 6 is a drawing of a six-throw crankshaft, showing the large bores in the main bearings and the blind-end bores in the crankpins. From 0.002 to 0.003 in. stock is removed, and inaccuracies are held to between 0.0003 and 0.0005 in.

Bores in cam-follower rollers are also Microfinished, two at a time per spindle, in one operation, following grinding. From 0.0003 to 0.0010 in. stock is removed on the diameter, in from 10 to 12 seconds honing time. Tolerances on straightness and roundness are 0.0002 in. and the surface finish registers 3 to 5 micro-inches, r.m.s.

Cross holes in the valve tappets for the roller pins have approximately 0.0005 in. stock removed on the diameter in one Microfinishing operation. Tolerances on these holes range from 0.0001 to 0.00015 in., and the surface finish is held to 3 micro-inches or less.

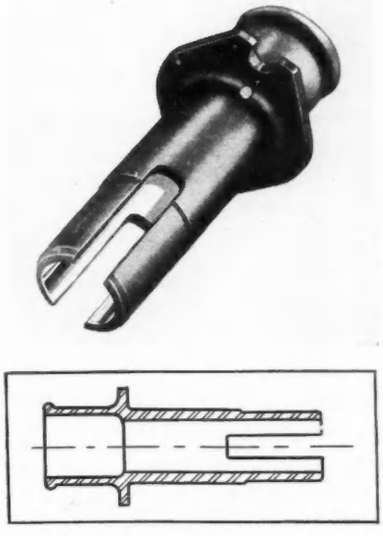


Fig. 7—Valve tappet guide of which the bore is Microfinished

In a carrier ring, twenty holes of 5/16 in. diameter and approximately 1¾ in. long are Microfinished in one operation, following reaming. About 0.002 in. stock is removed; accuracy is held to from 0.0002 to 0.0003 in., and surface finish to within 3 to 5 micro-inches r.m.s.

Gear pinions have their bore Microfinished, 0.0006 in. of stock being removed in one operation, in 40 seconds actual honing time. Tolerances on roundness and straightness are 0.0002 in.,

Fig. 8—Microfinishing cross-pin holes in propeller-blade rotating cam

and surface roughness is held within 3 micro-inches r.m.s. The operation is for clean-up and to prevent fatigue failure.

Certain bushings, such as that in the supercharger rear-housing and impeller-shaft bearing support, require a very close fit, not only to minimize wear, but also to furnish an effective oil seal. A certain steel bushing 2 3/16 in. in diameter and 1¼ in. long, with a hardness between Rockwell C36 and C40, is ground in a preliminary operation and then Microfinished in one operation. Approximately 0.0005 in. stock is removed in a floor-to-floor time of 5 minutes, roundness and straightness being held within 0.0002 in.

Two Microfinishing operations are performed on a propeller distributor valve, a tubular part with interrupted surface, 0.005 in. of stock being removed on the diameter. Roundness and straightness have tolerances of 0.0002 in., and surface roughness is held to 2 micro-inches r.m.s., to ensure a close fit of the operating assembly.

Microfinish honing is also widely used on parts of landing-gear shock absorbers. The cylinders of these shock absorbers are made of chromium-molybdenum steel of approximately the same analysis as S.A.E. X 4130. Bores or cylinders generally range between 1⅞ and 2 9/16 in., and lengths between 6⅝ and 16 in. The former practice was to bore, ream, grind and polish these cylinders, but they are now honed in two operations following rough-boring. From 0.010 to 0.015 in. of stock is removed on the diameter by honing. The diameter of the finished part is accurate to within 0.0005 in., and the finish of the surface is held between 1.5 and 2 micro-inches, r.m.s.

An interesting part is the cam by which the blades of a variable-pitch propeller are rotated. In this part there are cross-pin holes which are Microfinished following grinding, as shown in Fig. 8. About 0.001 in. stock on the diameter is removed in one operation, the tolerance on roundness being 0.0002 to 0.0003 in. and on surface finish, 3 to 5 micro-inches, r.m.s.

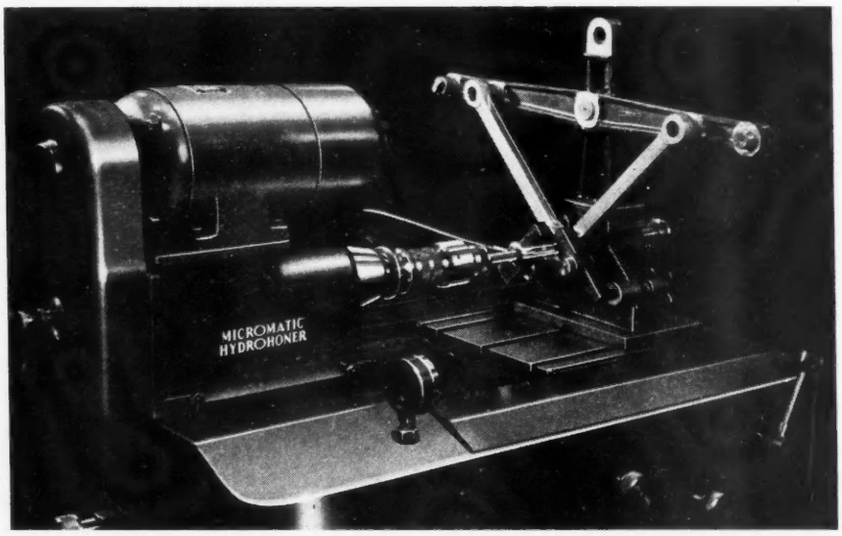
Microfinish honing has been adopted also as the final operation on hydraulic-brake-control units. The spider which takes up the brake torque has a blind-end bore in which there is a steel bushing. This latter is finish-honed in one operation following grinding. From 0.001 to 0.015 in. stock on the diameter is removed, and roundness and straightness have tolerances of 0.0002 in. Blind-end bores in the aluminum-alloy brake-control unit also are honed, in one operation, to improve the fits of the hydraulic assembly.

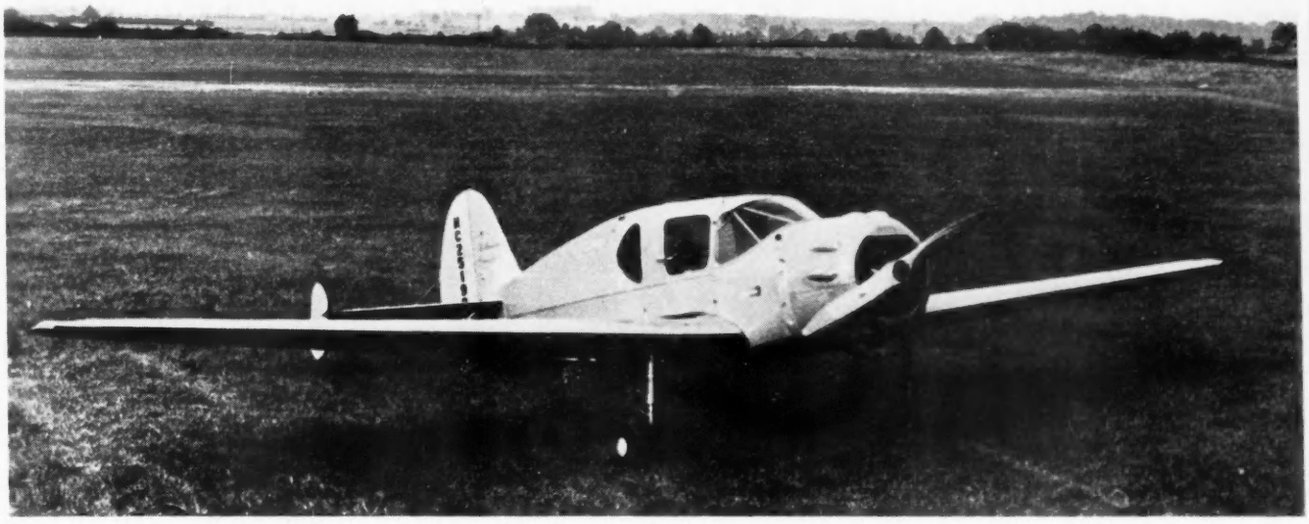
Blind-end cylinders forming part of the wing-flap mechanism, made of S.A.E. 4340 steel, are Microfinished in two operations following grinding. From 0.003 to 0.004 in. stock on the diameter is removed in the rough-honing operation, requiring 5 to 6 minutes, and from 0.0004 to 0.0007 in. in the finish-honing operation of 30 seconds. The wing flap is operated hydraulically, and the cylinder is fitted with a piston of synthetic rubber. High accuracy and smoothness are essential in the cylinder, as the assembly must pass inspection under 2500 psi. hydraulic pressure.

In one hydraulic surface control unit of aluminum alloy there are three bores which are Microfinished in

(*Turn to page* 96, *please*)

Fig. 9—Honing steel bushings in place in links of landing-gear-retracting mechanism





Bellanca "Cruisair" plane constructed largely from plywood bonded with phenolic resin

Plastics

used in the fabrication of larger parts of

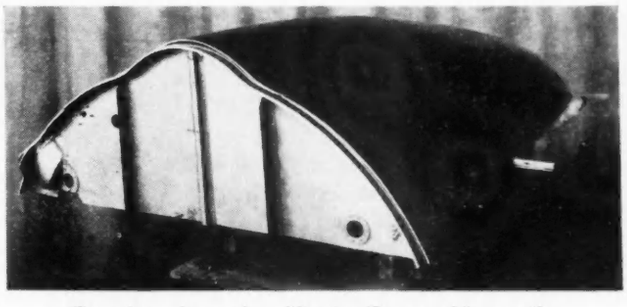
Aircraft

By HERBERT CHASE

MUCH has been heard and written within the last year or two about "plastic" airplanes, so called. Strictly speaking, there is no such product. Unless some new, low cost, high strength plastic is developed, it seems unlikely that there will be produced anything which is properly termed a "plastic airplane" if, by this term is meant a plane constructed largely of plastic. This is true because nearly all plastics now available are low in strength, relatively brittle and not well suited for structures which are heavily loaded and subject to shock. Most plastics are rather high in cost per pound, but this is offset to some extent by low specific gravity. Although some recently developed plastics, such as Nylon and Saran, are claimed to have the "strength of steel," their utility for aircraft structures is yet to be demonstrated and their present adaptability is restricted by high cost and limited availability. All ordinary plastic molding requires pressures of 2000 lb. per sq. in. upward. Presses large enough to produce this pressure over areas such as airplane wings are neither available nor feasible and molds of such size for such pressures are in the same category.

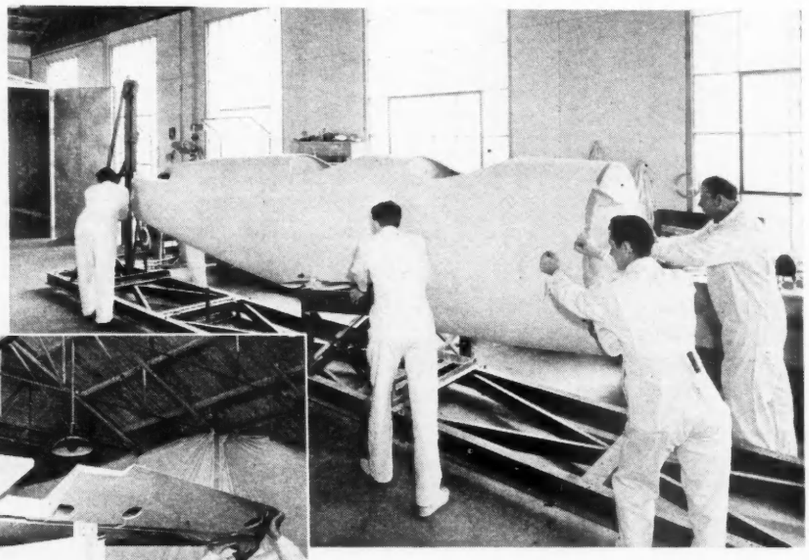
It does not follow, by any means, that plastics are without utility for aircraft construction. Quite the reverse is true. Their largest potential use, as far as aircraft are concerned, however, is to supplement and act as a binder for other materials, notably wood veneers. It is in this field that they appear destined to gain an important foothold. Planes made from wood veneers bonded into aircraft structures by plastics are often referred to as "plastic" structures, but this is no more logical than it would be, for example, to refer to a "glue" desk merely because plywood used in making the desk is put together with glue. In both cases the basic structure is wood and the adhesive is a supplementary but exceedingly valuable material.

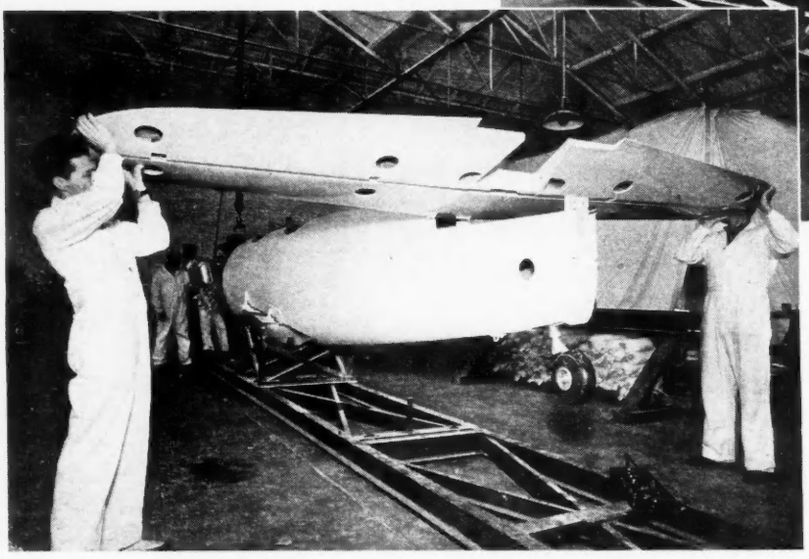
Although, in the past, many major parts of aircraft have been produced for plywood using glue as a binder, this practice proved too undependable because there was no way of injuring joints which would not weaken or ultimately fail or approach failure in service. None



Exterior view of a Martin Duramold nacelle, showing the compound curvatures which are feasible in this process.

Right: Jig on which the Timm fuselage shells are fitted over framing members, the joints being first saturated with phenolic resin. When assembly is complete, it is wheeled, still on the jig, into the oven in which the final curing fuses and sets all phenolic joints.





Left: After baking, units molded by the Timm process are assembled as here shown and the engine and other major metal elements are added to the plane before finishing coats of phenolic "paint" are applied.

of the animal glues are proof against water absorption in weathering and such absorption results in weakening and failure of the joints. Casein glue, based on an animal product, though more resistant to water than most animal glues, is also water absorbent and is weakened thereby. Glued joints are also subject to attack by fungi or do not protect the wood itself against such attack.

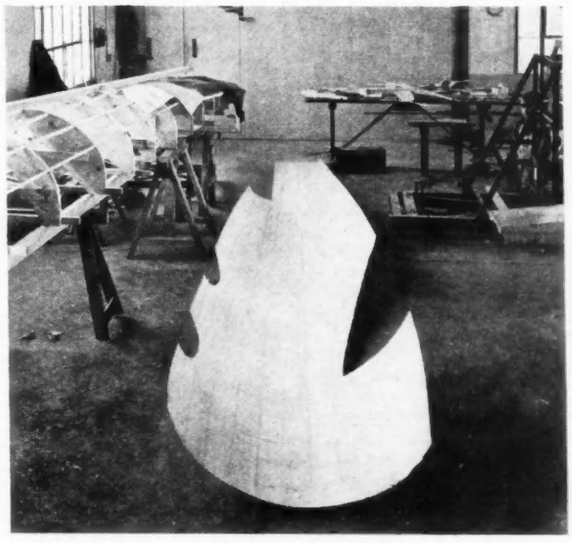
A great advantage of resins from which plastics are made, and especially the thermosetting phenolic resins is that, although they are very slightly hygroscopic, they are not weakened by absorption of moisture and plywood bonded with phenolic resins even withstands prolonged boiling in water. Then, too, the curing of phenolic resins renders them insoluble and infusible. Moreover, the setting makes them permanently stiff and, when they are used as binders for wood which is molded to shape, the shape is retained after molding. Molding also causes the resin to flow into the cellular structure of the wood and to form joints much stronger than the wood itself. Finally, neither the joints formed nor the wood treated are afterward subject to deterioration by fungi and they are proof against attack by insects, besides which the treatment makes them slow burning if not completely fire resistant. Several plastics are even more resistant to moisture than the phenolics, but all such are higher in cost and all in common use (except the urea type which is less water resistant) are of the thermoplastic type and are subject to softening at elevated temperatures. Some thermoplastics, such as Butacite, an acetate-butyrate, have been used, at least experimentally, as adhesives in aircraft part fabrication.

Although it is permissible to speak of molding large aircraft parts, such as a half shell for a fuselage, for example, from wood veneer by the use of a plastic binder, the molding is a quite different process from that of the ordinary molding of plastic in a steel mold, although there are points of similarity. In the common plastic molding, the plastic, together with whatever filler may be used in it is reduced by heat to a viscous liquid state enabling the plastic and filler to flow into the shape of the mold and to create, at least momentarily, a hydrostatic condition in which pressure is equalized throughout the mold cavity. Wood veneers do not flow to any considerable extent when molded to shape with a plastic binder, although there may be a considerable flow of the plastic itself under the heavy pressure imposed. It is necessary in molding with veneer to fit the wood into or around the mold and to employ some means of applying the plastic between layers before pressure is applied. Since a true hydrostatic condition is not established, it is not feasible to have both halves of the mold "positive" or solid; one-half must be yielding, unless the parts molded are shallow and relatively flat or unless some especial expedient is employed to apply the pressure uniformly to all points of the mold surface.

As far as the author has been able to determine and is permitted to reveal (in view of considerable secrecy maintained under present conditions), four general processes are in use in this country for fabricating aircraft parts by molding plywood with plastic binders. These are commonly referred to as the Duramold, Vidal, Aermold and Bellanca processes, respectively.

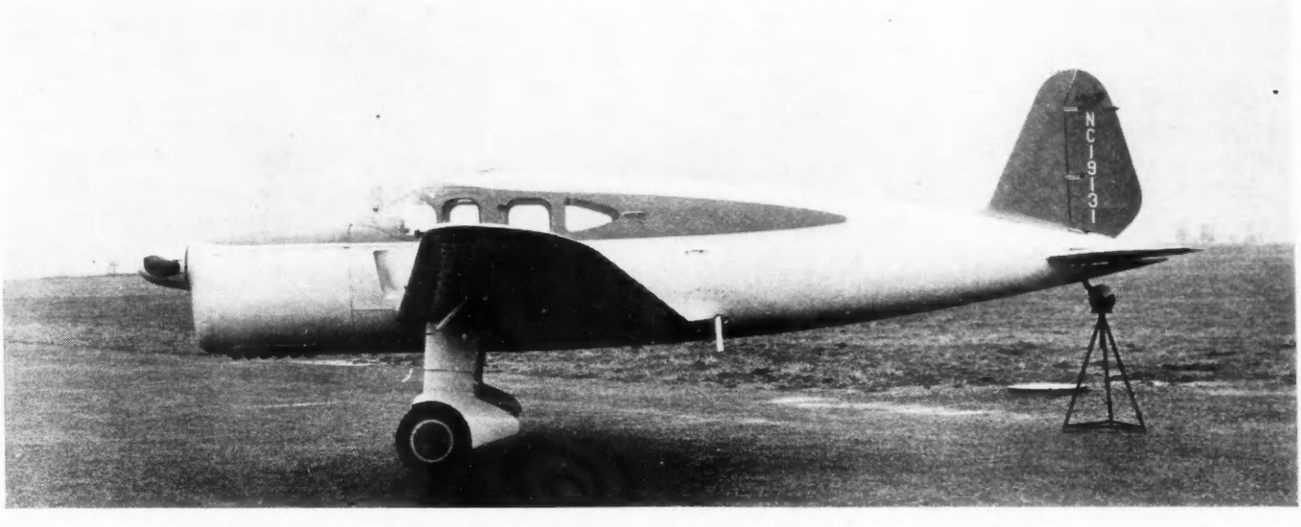
The Duramold process is understood to be controlled by The Duramold Aircraft Corp., a subsidiary of Fairchild Engine and Airplane Corp. and by the Haskelite Manufacturing Corp., the latter supposedly interested primarily in applications other than those for aircraft. An exclusive license for use in large aircraft has been granted to Hughes Aircraft Division, Hughes Tool Company, with whom Col. V. E. Clark, formerly of Clark Aircraft Corp. (also associated with Fairchild), is now connected. Col. Clark, when with Clark Aircraft, described Duramold (as a material as distinct from a process) before the S.A.E. in May, 1939, but did not state how parts made from it were molded.

In the Duamold process now used, although cast molds can be employed, they are usually made from smooth sheet metal. Duraluminum sheet 1/8 in. in thickness is commonly used. This is made possible because pressure and heat are not applied from one side only but from all sides by placing the entire mold with its contents and cover in a tank to which steam at about 100 lb. pressure and 300 deg. Fahr. is admitted. Since the mold is female and is made perfectly smooth on its critical inner surface, the molding is correspondingly smooth on its outer surface, where smoothness is a great advantage. Veneers used commonly range from 1/48 to 1/20 in. in thickness, hence they are quite flexible. Edges of strips of veneer are cemented together before the strips are set into the mold, as a rule. In some cases, however, as for spherical or other compound curved surfaces, it is necessary to use gore or segment-shaped pieces. Alternate layers of veneer are placed, of course, so that the grain of the wood in one layer is at right angles to that of the adjacent plies. As a rule, there is placed between the plies a sheet of Tego film, which is tissue paper impregnated with phenolic resin, but when, as for surfaces with compound curves, it is more convenient to use a resin in alcohol solution, this is done and the solution is sprayed on. The alcohol evaporates almost immediately, of course, leaving a coating of resin for bonding purposes. Adhesive tape is used to hold plies in position until molding begins.



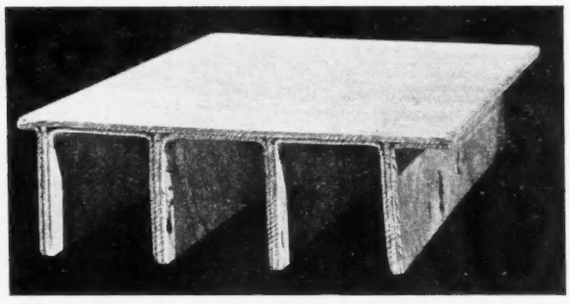
Partly fabricated shell produced by the Timm process over the rough wooden form shown at the left, and ready for molding to exact shape required in a metal mold, not shown.

It is not necessary, of course, to have the same number of plies over the whole mold area. The number can be varied to vary the thickness in proportion to the stresses subsequently applied. Since thick sections heat through more slowly than thinner ones, it is necessary to make certain that all the resin is fused to produce a perfect bond at all points, thermocouples with fine wire leads are embedded in the center of thick sections and the leads are carried outside the mold. When plies, resin and thermocouples are all in place, the contents of the mold are covered with a rubber blanket and the latter is clamped to the mold at the edges in such a



Completed Clark experimental plane (also known as the "Model 46 Fairchild" plane for private use) in which a Duramold fuselage was employed.

way that the contents of the mold is completely sealed between the blanket and the mold surface. Then a vacuum pump is attached to a tap or taps running through the mold and all air is exhausted, carrying with it such moisture or solvent vapor as may remain in the sealed space. Then the assembly is wheeled or slid into a steam tank, the latter is sealed and steam is admitted, subjecting the mold contents to a uniform pressure which forces the plies into close contact with the resin binder. At the same time, the steam supplies heat which passes both through the mold and through the rubber blanket and raises the mold contents to a temperature of at least 280 deg. Fahr. at all points. This assures fusing the resin and forcing it to enter the grain of the wood, finally making a permanent bond between plies when the resin sets, as the heat and chemical reaction within the resin cause it to do.



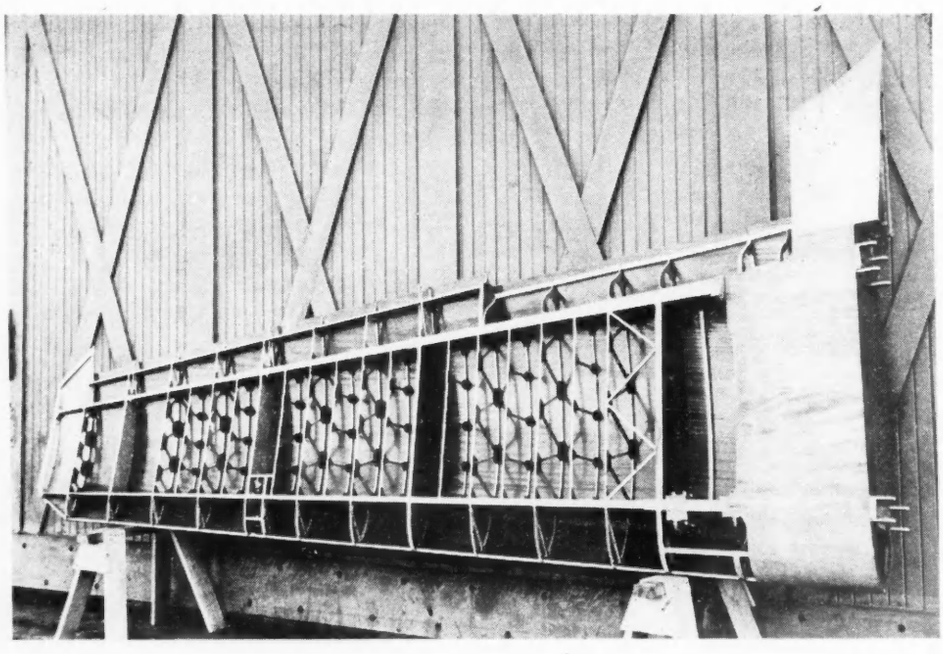
Aircraft flooring made by the Duramold process. Core plies are of poplar about 1/16 in. thick, both for the floor proper and for the stffening flanges at right angles thereto. At each side of the core wood are two plies of birch, those fitting the channels being formed in U-shaped section with a radius at the inner corners.

For moldings up to about 3/8 in. in thickness, the molding must remain in the steam tank about 10 to 12 min., but the mold is not removed until the thermocouples all register a temperature such as to indicate that the resin is completely fused and cured. In general, the completed molding contains from 10 to 14 per cent by weight of resin. After molding, the steam in the tank is exhausted and the cured moldings are removed. Rubber blankets ued range from about 1/8 to 1/4 in. in thickness and can be used over again from 40 to 50 times. Of course, several moldings can be made at one time if there is room for them and for the molds in the tank. Tanks up to 10 ft. in diameter and 30 ft. long are now reported in use.

In the process outlined, it is feasible to mold shells or part shells and to apply internal reinforcements such as ribs, but details of construction cannot be given out at present. Half shells can be fastened together at scarfed joints which yield a perfectly smooth exterior surface. Molded parts can be fastened to metal by riveting, if required, but, as one objective is to avoid even the small projections of rivet heads, exposed riveting is avoided as far as possible.

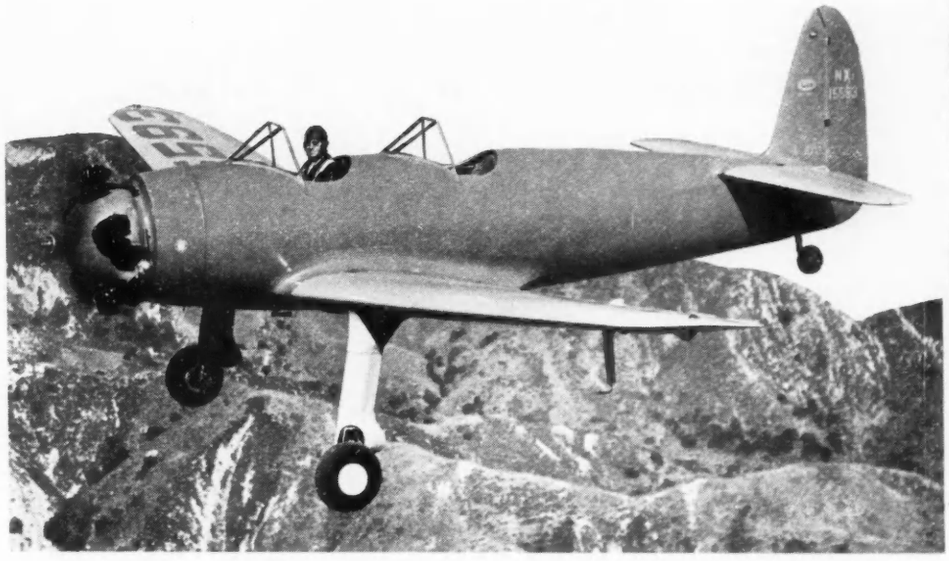
Many experimental parts and much of the assembly of complete planes have been made with favorable results in tests, both static and flight, and with noteworthy reduction in drag and consequently in power required, but space for details is lacking here. Portions of wings for a trainer plane are now reported in regular production by the Duramold process, but particulars are not available for publication. Some experimental parts here illustrated were produced by the process. In the same process but performed by using a rubber bag or cover shaped especially for the purpose there is now in production a reinforced flooring for aircraft said to weigh only 0.7 lb. per sq. ft. but capable of supporting a load of 400 lb. distributed over this area. An illustration of this product is appended.

The regular Duramold process is not confined to use if forming parts from plywood. It is being used also to form short lengths of spruce and of other woods up to 7/8 in. thick into spars, some of which are bent. These are said to be no more costly and at least as strong as are long (unlaminated) spars of straight grained spruce, the supply of which is quite limited.



Partially assembled wing made by the Bellanca process in which plywood veneers and presumably also some if not all the frame elements are joined by Catalin phenolic resin, applied in a water solution with an accelerator which permits of curing at 140 deg. Fahr.

Spars can be made up from short pieces of board as wide as are available. Scarf joints, said to be at least equal in strength to the wood itself, are made where one short length joins the next one. A wider spar "plank" made in this fashion can be sawed later into whatever widths are required. Lamination, however, requires about 2 hr. because the heat must penerate through so great a thickness of wood. Spars 2½ in. thick are now in production.



Experimental Timm plane in flight. The fuselage, wings and tail elements are understood to be molded from plywood, all joints, including those between flies, being made with phenolic resin.

In the second process, developed by the Aircraft Research Corp. (which is closely affiliated with the United States Plywood Corp., said to be using the process for boat construction, under license) a somewhat similar procedure is followed with the important difference that, according to the best information available, male molds are used and reinforcing ribs and other stiffening parts are reported as being molded in place. What has been termed "fluid" pressure—meaning either liquid or gas —is employed, the gas being steam in some cases and air in others. Practically all details are withheld, but it is understood that, after the wood veneers and stiffening members, as well as the plastic binder are in place, the assembly is covered with a rubber blanket and is subjected to heat and pressure in a tank, much as in the Duramold process. It is said that the mold can be of wood or metal and that it is slotted to receive the stiffening elements which, presumably, are cut to required size and shape from flat plywood of the required thickness. Apparently, after the stiffening elements are in place in the slot of the male mold, plies of wood and plastic are applied to form a shell, much as in the earlier Duramold process, but with plastic on the edges of the stiffening parts so that they are fused to the shell in the curing process. Stiffening parts would, of course, have to be of such shape and be so disposed that the assembly can be lifted off the mold when completed. Both thermosetting plastics, which are permanently hard and insoluble when cured; and thermoplatics, which are capable of being softened by heat after molding, have been used in the Vidal process.

At least one complete plane made by the Vidal process is reported to have passed static tests and to be undergoing or ready for flight tests. A basic trainer is said to be in process but not yet approved. Seaplane floats up to 20 ft. long and other large plane units have been turned out on at least an experimental scale and an order for an experimental bomber fuselage 45 ft. long has been received. United States Plywood Corp. is understood to have been manufacturing boats at a rate of fifteen per day by the Vidal process, but this appears to be the only commercial application to date. It is understood that U. S. Plywood Corp. has undertaken to produce in quantity aircraft elements and other types of parts made by the Vidal process when these are ready for manufacture.

Although the Aermold process, employed in the new and rather small plant of the Timm Aircraft Corp., has some points in common with the other two processes already described, there are also points of difference. Materials used are said to be confined to spruce plywood 1/24 in. thick and certain special phenolic resin solutions. In the initial operation, veneers the full length of the part to be molded are stretched over a rough wooden form having a shape corresponding closely to that of a metal mold, made with greater precision and used subsequently. After the first layer of plywood is in place on the form, a thick coating of phenolic resin, in solution, is sprayed on. Then another layer of plywood is applied with its grain at right angles to that in the first layer, after which this layer too is similarly sprayed. The process continues until the required thickness is built up, the final layer being bound in place by tape, if this be required at any points. Then the shell formed by the plies is transferred to a metal mold and a pressure of 50 lb. per sq. in. is applied for a period of two hours to force the resin into the pores of the wood. Apparently the resin used, which of the phenolic type, is capable of some cold setting (or this may be induced by use of an accelerator). Some heat presumably is applied, as the mold is said to be kept "warm." In any event, information supplied indicates that the resin begins to set or solidify, giving "definite rigidity" to the shell before it is removed from the mold. Further and complete setting is brought about, presumably, by subsequent baking, but before this baking takes place, the shell is transferred to an assembly jig where it is

(*Turn to page* 100, *please*)

New Plan for Bomber Building Centers on Automobile "Big Three"

International Photo

(Above) a peek inside of the pilot's compartment of an almost completed Martin I 67 F bombing plane, one of a fleet in production at the Martin plant in Baltimore.

(*Continued from page* 57)

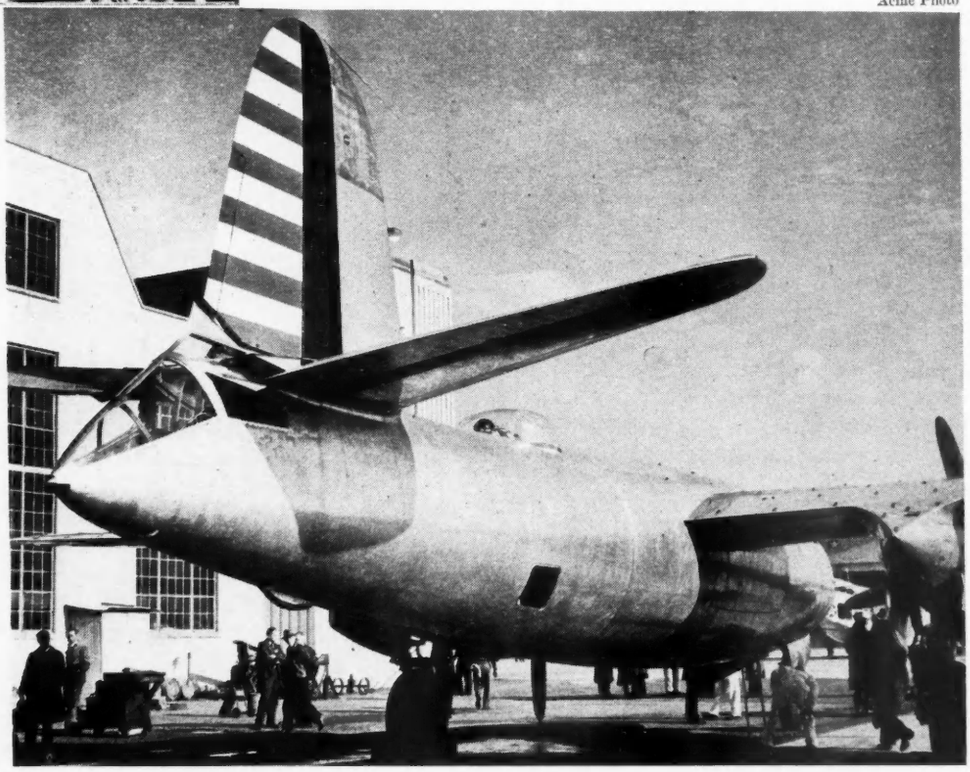
ment. Then it would let a sub-contract to Ford for the wing and fuselage parts and sub-assemblies, while Pratt & Whitney would receive a sub-contract for the engines.

Then Ford would put together the sub-assemblies and ship them to either Fort Worth, Tex., or Tulsa, Okla., where $10,000,000 assembly plants are to be built financed by the government. The Fort Worth plant is to be operated by Consolidated, while the Tulsa plant will be run by The Douglas Aircraft Corp. of Santa Monica, Calif. Douglas is to cooperate with Consolidated on assembling the B-24 bomber.

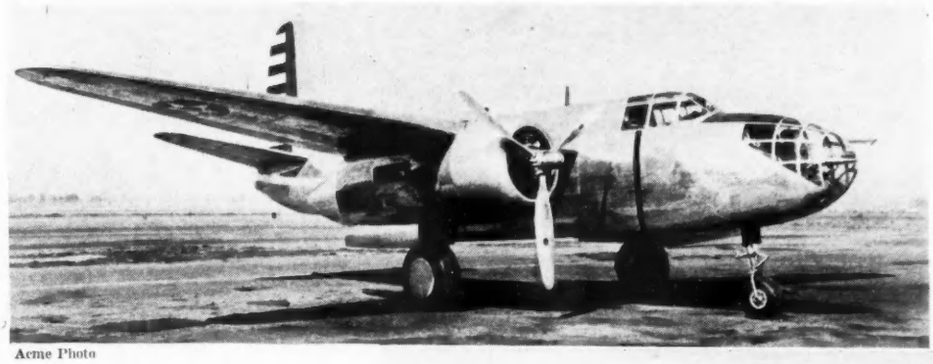
(2) General Motors would be responsible for the North American B-25 two-engined bomber. This plane is driven by two 2000-hp., 18-cylinder, Pratt & Whitney engines of the type that Ford is building plants to produce. It has a 2-ton bomb load and can attain 350 m.p.h. North American Aviation Corp., of Inglewood, Calif., which is a GM stock-controlled subsidiary, would be the primary contractor. GM would ship the sub-assemblies to North American's Government-financed assembly plant at Kansas City, Kan.

(3) Chrysler would accept responsibility for the Martin B-26 attack bomber, which has a speed close

Acme Photo



The Martin B-26 medium bombers which are being built for the Army Air Corps have all of the latest features required for modern warfare including a rear gunner's turret. Other features include self-sealing fuel tanks and protective armor. It is reported to have a speed in excess of 400 m.p.h. Chrysler has accepted responsibility for the production of the fuselage and wing parts of this type in the new program. The B24 and B25 are shown on page 57.



Acme Photo

(Left) The Douglas Aircraft Co. recently delivered this new A-20A attack bomber to the U. S. Army Air Corps. This design combines the features of a fighter and light bomber and is based on the specifications of the Air War Board. It is powered by two 14-cylinder Wright Cyclone motors, has tricycle landing gear and carries a crew of three. ←

Acme Photo

(Right) New Douglas twin-motored DB7 attack bombers for Great Britain wait for final touches at the factory in Santa Monica before being released for shipment. →

to 400 m.p.h. This plane weighs 26,000 lb., can carry 5000 lb. of bombs, and is powered by two Pratt & Whitney 2000-hp. engines. This is rated the fastest bombing plane in the world. The Glenn L. Martin Co., of Baltimore, would receive the Government contract and would assemble the planes at its projected assembly plant in Omaha, Neb.

Final details of this bomber production plan remain to be worked out by the War Department and Defense Commission, but it has the endorsement of the Air Corps. The original request made by William S. Knudsen, defense production chief, last October, was for the automobile industry to accept responsibility for 12,000 bombers split among the three types recommended by the Air Corps. When President Roosevelt promised increased aid to Britain, the projected output was boosted to 24,000 bombing planes. However, the first order has been scaled down to 3600 planes, 1200 of each type, and the War Department is prepared to ask the new Congress for a $1,000,000,000 appropriation for these planes, engines and assembly plants. Production above the initial 3600 is expected to be comparatively easy. The four assembly plants are expected to turn out 300 bombers per month, thus requiring a year's time for completion of the first order.

The new plan in no way supersedes the Automotive Committee for Air Defense but merely uses its findings in a different manner. The committee has been functioning since Nov. 1 in its quarters leased from the Graham-Paige Motors Corp. in Detroit. More than 800 representatives of approximately 400 manufacturing plants have visited the committee headquarters and viewed the representative parts on display there. The representatives of these firms have listed the production facilities, floor space and labor available for making parts.

An analysis of the production facilities available in automotive plants by the committee's technical experts leads them to believe that the industry is capable of manufacturing the parts required for completion of the bomber program. This contemplates use of the sub-assembly method, utilizing existing plants and existing machinery adapted for the purpose, plus the necessary new tools, dies and jigs which the tool and die industry can produce. Office space is available at the committee's Detroit headquarters where Ford, General Motors, Chrysler and the aircraft companies can install purchasing, technical and inspection representatives to assist manufacturers in making bids on parts and sub-assemblies.

However, the time lag is still an important factor in the bomber program. It may be four to six months before production of parts and sub-assemblies really gets under way and quantity production of the bombing planes is not likely before early 1942. A bomber requires 90,000 to 100,000 man-hours of labor.

Also, the B-24 and the B-25 bombers are hardly past the flight test stage, while the B-26 has only recently been placed in production by Consolidated.

(*Turn to page 96, please*)

Aviation Discussed at the S.A.E.

(*For papers of general interest*

THE S.A.E. Aircraft meetings were of more than usual interest. Following are a few of the papers abstracted:

Flutter

A HIGHLY mathematical paper on the flutter problem was presented by S. J. Loring of Vought-Sikorsky Aircraft. The author defined flutter as "a self-excited or unstable oscillation arising out of the simultaneous action of elastic, inertia, and aerodynamic lift forces upon a mass or a system of masses." This type of vibration has been observed most frequently in aircraft but is known also in some other fields, examples being the "galloping" of sleet-covered electrical transmission wires in high winds and the recent spectacular vibration of a suspension bridge which eventually caused its failure. Flutter is an increasingly important factor in aircraft design, because of the trends toward higher speeds and use of the more flexible structures which result from cutouts for access, visibility, or equipment. At present the most useful theories for predicting flutter consist of dynamic analyses, with the aerodynamic forces included, of very simple systems which are made to represent, by analogy, the more complicated systems occurring in practice. Success in predicting flutter speeds in this manner has been gratifying in cases where there has been a close analogy between the actual system and the simple one which has been analyzed; too often, however, there is little or no analogy between actual structures for which flutter characteristics are desired and the simple systems. In the latter cases the existing flutter theories cannot be used very satisfactorily. For example, there are several possible flutter modes of conventional airplane tail surfaces.

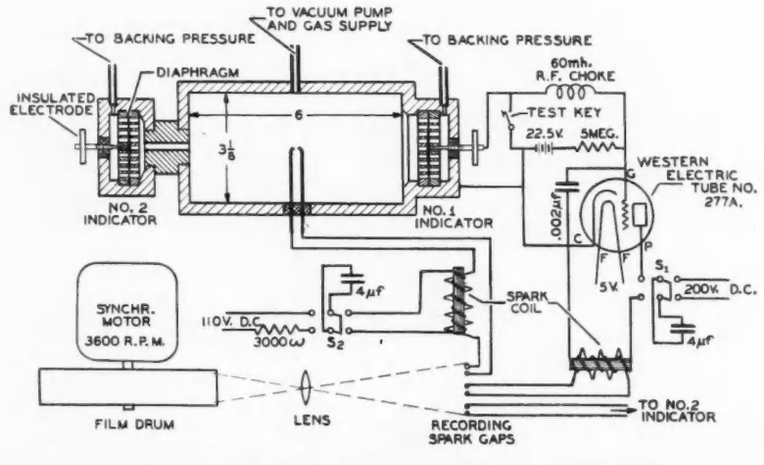
The author in his paper outlined a general approach to the flutter problem by the use of some well-known principles and relations of dynamics. Equations were derived by means of which it is said to be possible to determine the flutter speed of the wing or tail surfaces of any conventional airplane. Since the process by which these equations were obtained is perfectly general (within the limits of a linear theory), the equations can be corrected or extended when more accurate or more general air-force solutions become available.

Bomb Test

DEVELOPMENT work on diaphragm indicators for use on explosion bombs was described in a paper by Frank R. Caldwell and Ernest F. Fiock. It was desired to get accurate records of the pressure variation when an explosive mixture is fired in a bomb. A diaphragm-type indicator which shows when a definite pressure is reached was chosen as most suitable for the purpose, but preliminary experiments were necessary to determine the optimum dimensions and the most suitable methods of mounting and recording.

Test apparatus (see illustration) was built which provided for the comparison of two indicators differing only in one detail of design, and for the investigation of a number of design features through simple mechanical changes. One indicator was mounted at each end of the cylindrical bomb, so that both were subjected to the same pressures. Tests were made on indicators of the balanced-diaphragm type, a very flexible circular diaphragm being clamped at the rim between two perforated supporting disks. The number and pattern of perforations in the inner backing disk and the thickness of the latter were varied. To provide for the necessary movement of the diaphragms, the adjacent surfaces of the inner disks were made cone-shaped, with an altitude of approximately 0.004 in. Outer backing disks were identical in all cases, both of their surfaces being plane and normal to the axes, and they were perforated with 442 1.5-mm. holes, spaced 2 mm. between centers, and a ring of six 1-mm. holes around a central 2-mm. hole through which the end of the insulated electrode passed. At the center of the outer backing plate there was an electrode of stainless steel, with a rounded and polished contact. It was threaded through a mica-insulated gland.

In using this type of instrument, a known constant backing pressure was applied continuously to the outer face of the diaphragm. When the pressure



Apparatus for testing pressure indicators on bomb

Annual Meeting

(turn to pages 74 and 82)

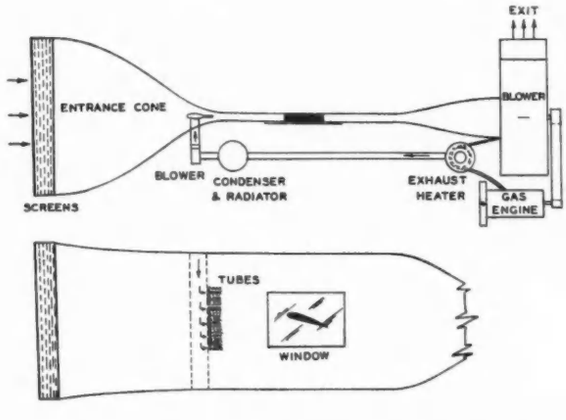
on the explosion side just exceeds this backing pressure, the diaphragm moves quickly from its inner to its outer support, where it completes an electrical circuit by means of which the instant of contact is recorded.

To be able to measure the extremely small time intervals involved, three recording spark gaps were focused on a film carried on a drum driven at 3600 r.p.m. by a synchronous motor. The first spark was in series with the igniting spark and recorded the instant of ignition. The other sparks followed on the record as each diaphragm made contact with its insulated electrode. Since the velocity of the film was known, the time elapsing between ignition and the operation of each indicator could be obtained directly from the photograph.

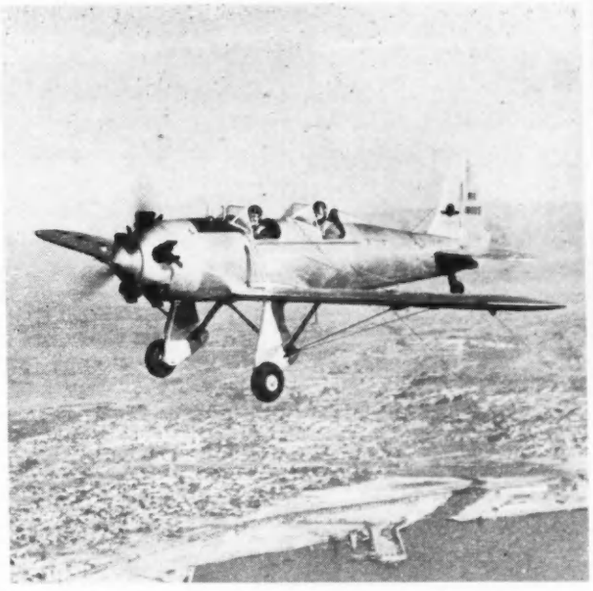
The paper dealt exclusively with the design of diaphragm-type indicators, among the factors discussed being temperature effects, lag in the recording system, pitting of contact points, inertia of the diaphragm, effects of diaphragm dimensions, effects of radial tension in diaphragm, effects of surface conditions of diaphragms, effects of projections into bomb around diaphragm, and accuracy of observed pressures.

Smoke Tunnel

A SMOKE tunnel for visualizing air flow over airplane elements, etc., by means of smoke lines was described in a paper by Roger W. Griswold, II, aerodynamic consultant. As shown by the sketches, the tunnel is of the non-return-flow type, a continuous supply of fresh air being needed when smoke lines are injected. The test area, which is spanned by the model so as to give two-dimensional flow, has a single narrow rectangular cross section of 6.5 ft. by 4 in. A large heavy plate-glass window, 2½ by 4½ in., is mounted flush with the internal surface in the front face of the tunnel to expose the model to view, together with a field of 25 steamlines. Photoflood lamps sunk in the top and bottom tunnel walls provide an effective method of indirect lighting, sufficient for direct visual observation and for ordinary photography, but not for high speed photography. The window is hinged and can be easily opened when it is desired to adjust the model in place.



Two views of the Whippoorwill smoke tunnel



The Ryan ST-3 low wing open cockpit monoplane being produced as a trainer for the U. S. Army. This one is powered with a Kinner five-cylinder air-cooled motor. Six-cylinder in-line, air-cooled Menasco motors are also used on this model.

Models intended for study of high-lift flow phenomena are usually of 24 in. chord, those used only for minimum drag comb pitot tests run up to 48 in. chord, though a possible maximum of 6 ft. chord for this latter case might be used which could thus provide a test Reynolds' Number of about 4.5 million. Ordinary models are simple to make in comparison with the usual three-dimensional type of wind tunnel model. All that is required is cutting out two solid ribs on a jig saw and wrapping a sheet metal cover about same. Other models, involving internal flow for instance, where such phenomena must also be visualized with internal lighting, are relatively more complicated.

Wind Tunnel

A WIND tunnel is used to determine coefficients of lift, drag, etc., for airplanes and airplane parts, by means of scale models. The scales of the wind tunnel give directly the coefficient applicable to the model, and these are identical with those for the full-scale model or actual plane only if the Reynolds number is the same. The Reynolds number is given by the expression

$$R = \frac{\rho v l}{\mu} l$$

where ρ is the density of the fluid; v, the velocity; l, a

(*Turn to page* 98, *please*)

GENERAL ELECTRIC COMPANY, following a long-established practice, has again issued a review of its contributions to engineering progress during the past year, the author being Guy Bartlett. It is pointed out that in the course of the year General Electric was called upon by the Army, Navy and Air Corps for a wide variety of technical products for direct armament, ranging from marine turbines to small airplane instruments; it was also called upon by industry for electrical apparatus of all kinds for the expansion of manufacturing facilities required for defense production. Here are some items of more or less direct interest to the automotive field.

Instruments

Special instruments and measuring devices newly introduced or decidedly improved during the year were: Thickness gages for measuring materials having only one side available, one a magnetic gage for sheet steel and the other an eddy-current gage for non-magnetic metals; two types of cathode-ray oscillographs for handling transient-voltage problems in apparatus and circuits; a photoelectric recorder to measure and record consecutively the temperatures of 80 thermocouples; a gage for determining the pressure on machine tool bits; a color-temperature pyrometer; a photoelectric time-interval meter; a transmission photometer for light-transmission measurements of spectographic plates, films, etc.; an improved sound-level meter; an abrasion comparator for measuring wear resistance of film-coated magnet wire; and a 1000-watt oscillator with wide frequency range for vibration studies.

Motors

Conspicuous among the important and noteworthy changes made during the year in motors were those incorporated in the new open squirrel-cage induction motors, named Tri-Clad. The new motor meets the recently adopted NEMA frame assignments. It features modern "streamlined" appearance; more complete protection—through use of a cast-iron frame—than previously available except in especially enclosed machines; major advances in the insulation of current-carrying parts; and improved bearing design and lubricating arrangements. It incorporates the cast-aluminum rotor, pressure-relief system of greasing for the ball-bearing motors.

Single-phase capacitor motors were designed with the same type of cast frame, insulation,

MEN and

Automatic jig boring machine is designed for speed, flexibility and convenience in layout

MACHINES

ventilation, and protection as the companion polyphase motors.

A triple-voltage connection was developed for making an induction motor suitable for operation on 220, 208, or 199 volts, without change in torque, starting kva., full-load speed, or efficiency.

A new line of direct-current motors features compactness and improved protection. A new design of rolled-steel frame and improvements in end-shield and bearing-bracket construction combine to give these motors excellent protection from external damage. Use of Formex wire coils and Glyptal insulating varnish provide high resistance to impacts, abrasion, and the action of foreign materials, as they also do in the Tri-Clad motor.

For adjustable-speed drives in the smaller horsepower ranges, a speed variator was developed to operate from an alternating-current source. A generator-voltage control system provides wide ranges of adjustable speed.

Dynamometers

Increasingly larger dynamometers were constructed during the year, both in terms of maximum horsepower and in torque ability at low speed. Inductor-type equipments were built up to 4000 hp. at 500 r.p.m.; and a pair of direct-current machines was designed to measure accurately 40,000 lb-.ft. at 1 r.p.m., in addition to the ordinary higher speed ratings.

Welding

Power-factor correction was built into a new design of 300- and 500-ampere arc-welding transformers, eliminating the objection of low power-factor encountered with conventional welding transformers of large capacity. A low-priced 200-ampere D.C. arc welder, operating at 3600 r.p.m., was produced for heavy-duty service.

In a new method used by the Midland Steel Products Co. to make the box-section frames for an automobile manufacturer, 24 automatic arc-welding sets are operated on fixtures so arranged that a continuous bead of metal is laid practically the full length of the frame in four locations.

Welding electrodes were improved to increase ease of manipulation and speed of deposition, and new electrodes developed to meet special requirements, such as for hard surfacing applications.

For the energy-storage method of welding, applied extensively by aircraft and other manufacturers, two new types of control were developed.

Industrial Heating

Drycolene, consisting of about 78 per cent nitrogen, 20 per cent carbon monoxide, and 2 per cent hydrogen, was produced as a new protective atmosphere for heat-treating steel without decarburization.

In a new line of gas carburizing furnaces, propane is the source of carbon. Carburizing time and cost are greatly reduced, since packing material is not required.

For an induction heating equipment there was developed a compact motor-generator type of frequency changer for 9600-cycle output, requiring minimum space and making the equipment portable.

A New Type of Jig Boring Machine

A NEW TYPE of jig boring machine possessing great flexibility—the Autometric Jib Borer—has been placed on the market by the Meyer Mechanical Laboratory, San Francisco, Calif. The Model A, a general-purpose machine, intended for shops which have but one jig borer, may be used for jig-boring operations, including layout work, and may also be impressed for handling economically a wide variety of small-lot production where the cost of jigs and tools may not be warranted.

The Model B machine is substantially the same as Model A, except that it is equipped with a fixed rectangular table instead of a rotary table which is standard on the Model A. The rotary table may be supplied for hand operation or with power drive.

The vertical measuring range of both machines is 10 in., horizontal range, 16 in. Micrometer dial verniers permit measurement accurately to 0.0001 in. Carriage power feeds are continuously variable, between limits of 0 and 3½ in. per min. Ten spindle speeds are available, up to 2350 r.p.m. In addition there are four speeds for power rotary table operation, ranging from 40 to 437 r.p.m.

The machines are fitted with built-in measuring counters, built-in lighting, built-in motor drives and wiring. They handle the full gamut of operations—drilling, milling, reaming, and boring.

The machines take a floor space of 38 x 48 in. and are 68 in. in height. Net weight is about 2600 lb. Extra equipment provides for higher spindle speeds up to 7000 r.p.m.

(*Turn to page* 95, *please*)

47

Hardenability of Steels

See Pages 70 and 82 for abstracts of other SAE papers. Still more will appear in early issues

Automotive MATERIALS

DURING the past several years a number of tests have been developed for determining the specific hardenability of shallow-hardening steels. Various reports on the subject have been made to an S.A.E. Committee on Hardenability, and at the annual meeting of the Society one session was devoted to a symposium on the Hardenability of Steels.

Several methods for measuring hardenability have been proposed; each one embracing a limited field of cooling rates and hardenabilities, and each one proposing to define the steel in certain empirical or arbitrary terms. One of the earliest tests, the Shepherd test, rated the steel in terms of the hardness penetration in a ¾-in. round bar quenched in brine solution. Burns, Moore and Archer devised an arbitrary formula for rating steel in terms of the shape of the hardness penetration curve in a 1-in. round. Asimow, Grossmann and Urban proposed to describe hardenability in terms of the size of round bar that would just harden to the center when quenched with the ideal quench. Queneau and Mayo have proposed that hardenability be expressed in terms of a line showing the depth to which a steel will harden in various sized round bars.

Several fundamental concepts with respect to the reponse of steel to quenching operations have been established in recent years. One of these is that the hardness attained with any particular grade of steel is a function of the rate of cooling through some particular temperature, such as 1100 or 1300 deg. Fahr. The Jominy-Boegehold test, first described in a paper read before the American Society for Metals in 1938, is based on this principle. A bar of fixed dimensions is subjected to varying cooling rates along its length, and the Rockwell hardness is determined as a function of the cooling velocity at 1100 or 1300 deg. The Jominy-Boegehold test gives the hardenability of any particular grade of steel in terms of its critical cooling velocity—the cooling velocity required to obtain a given Rockwell hardness.

Grossmann has introduced the concept of the "critical bar diameter," which he defines as the diameter of a round bar which just hardens through for any given heat of steel. In the case of 1.10 per cent carbon tool steels it has been found that a Rockwell of C-55 is generally associated with the inflection point of any Rockwell contour curve, i.e., C-55 is the hardness of a structure composed of 50 per cent martensite and 50 per cent troosite. This Rockwell hardness of C-55 can also be shown to be the boundary line between etched case and core.

Abstracts of the various papers included in the symposium on the hardenability of steels follow:

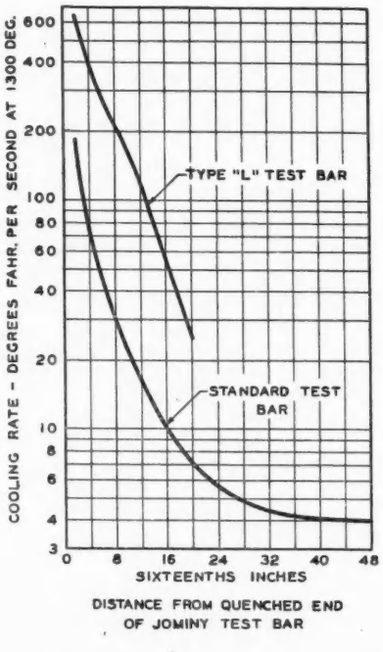


Fig. 1—Cooling rates at different distances from the quenched end of the Jominy standard and Type L test bars.

A. L. BOEGEHOLD of the G. M. Research Laboratories Division, in a paper on Hardenability Tests for the Selection and Specification of Automotive Steels, said a standard hardenability test is necessary for the determina-

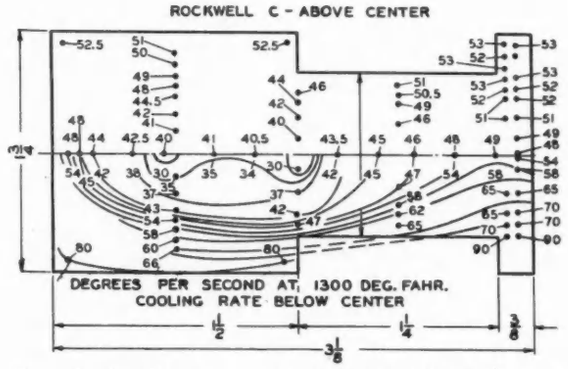


Fig. 2—Cooling rates at various points of cross section of spool-shaped article.

tion of the relationship between hardness and cooling rate for each steel. Such a procedure must furnish data bearing on the relationship between hardness and cooling rate, and must be applicable to a wide variety of steels, section sizes, and cooling rates. More specifically the requirements the procedure must meet may be stated as follows:

1. The hardenability test bar shall be inexpensive and of a size that can be cut from any size stock that may be purchased for manufacturing parts.

2. Preparation for making hardness tests after hardening shall be inexpensive, and the least possible number of hardness determinations should be made.

3. One test bar shall yield hardness results representing a wide range of cooling rates.

4. The different rates of cooling in the test bar must be so located as to permit ready and accurate measurement of these cooling rates.

The author said the Jominy "end-quench" hardenability test was developed with requirements 1, 2 and 3 as a guide, and it turned out that the test bar also met requirement 4, the need for which became apparent only as the work progressed. Three types of test bars, all of the end-quench variety, are necessary to cover the desired range of bar sizes and cooling rates.

The author asserted that the Jominy test is the only one so far proposed that makes possible accurate measurement of a wide range of cooling rates and to determine the fundamental relationship between cooling rate and hardness. Once this relationship has been determined, it is possible, by substituting the cooling rate for the corresponding hardness, to easily determine the cooling rate at any place in an article of any shape. Knowing the cooling rate, we know what hardness to expect in that object when made from any given grade of steel, by simply referring to the hardness-cooling rate curve for that steel.

The Jominy end-quench hardenability test furnishes data for a curve known as the H-CR curve (hardness-cooling rate curve). The data are obtained by substituting cooling rate values for distances from the quenched end of the test bar. Fig. 1 shows cooling rates at different distances from the quenched end of the standard test bar and the Type L test bar.

Let us consider the spool-shaped piece Fig. 2 as an object on which to illustrate the proposed method. We first determine the cooling rate at various points, by making the object out of low-hardenability steel, quenching in oil or water (whichever is to be used in production), determining the hardness at various points in the cross section, and finding the cooling rates corresponding to these hardness values by referring to an H-CR curve for the steel used.

In Fig. 2 the hardnesses resulting when the spool is made from 5130 steel and quenched in oil from 1675 deg. Fahr. are marked on the upper half of the cross section. Fig. 3 is the H-CR curve obtained from a Jominy test bar made from the same bar of 5130 steel as used for the spool and quenched from 1675 deg. Fahr. From this curve are picked the cooling rates corresponding to the hardness values shown in the upper half of Fig. 2. These cooling rates are also plotted on the lower half, and iso-cooling curves are drawn through the points. A temperature of 1675 deg. Fahr. was selected because the intention was to carburize

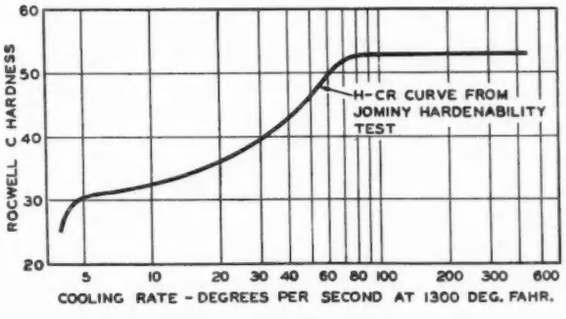


Fig. 3—Hardness-cooling rate curve of 5130 steel quenched in oil from 1675 deg. Fahr.

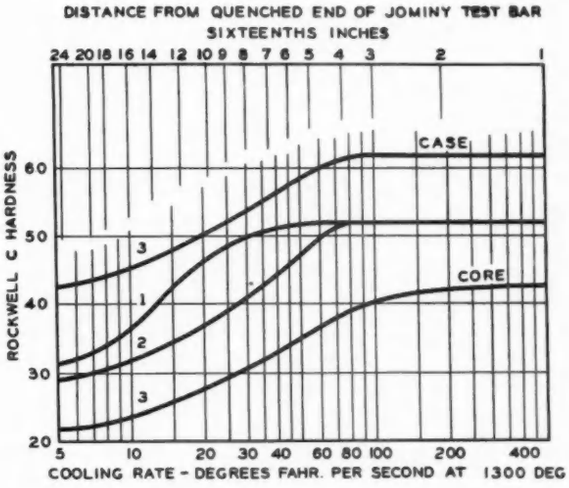


Fig. 4—H-CR curves for steels which will meet the three assumed requirements

the object sufficiently to provide a hard surface, relying on the hardness developed in the 0.30 per cent carbon core to back up the light case under compression loads.

Step No. 2 is to decide what hardness is required in the object. Three possibilities are that (1) the as-quenched hardness must be 50 Rockwell C or more throughout, (2) the as-quenched hardness must be 50 Rockwell C or more to a depth of at least ¼ in. below cylindrical surfaces of 1¾-in. diameter, and (3) the hardness must be 60 Rockwell C to a depth of 0.025 in. and the core hardness 30 Rockwell C min.

To facilitate finding a steel meeting the foregoing three requirements (step No. 3), the H-CR curve dictated by these requirements is shown in Fig. 4. Curve 1 is so drawn that for all cooling rates above 30 deg. Fahr per sec. (the lowest cooling rate in the spool), a hardness of 50 Rockwell C is obtained. Any steel having an H-CR curve coinciding with or to the left of curve 1 will meet the first requirement. Curve 2 is so drawn that for all cooling rates above 59 deg. per sec. (the lowest cooling rate at a depth ¼ in. below the 1¾-in. cylindrical surface) the hardness will be 50 Rockwell C or higher. This curve is practically the same as that for 5130 steel, and any steel having an H-CR curve lying to the left of curve 2 will meet the second requirement. Curves 3 (for the case and core respectively) are the H-CR curves dictated by the third requirement. From the iso-cooling curves in Fig. 2 it is seen that the line for 60 deg. Fahr. per sec. comes very close to the surface at the junction between the 1-in. and 1¾-in. cylinders. This, then, is the lowest cooling rate at the surface, and to meet the third requirement the steel must reach 60 Rockwell C at any cooling rate above 60 deg. Fahr. per sec. Similarly the lowest cooling rate in the core is 30 deg. Fahr. per sec., so the curve for the core steel will pass through Rockwell C 30 at 30 deg. Fahr. per sec. cooling rate. Any steel having an H-CR curve lying to the left of curve 3 will meet the third requirement.

Step No. 4 consists in examining the H-CR curves available to see which steels will meet these requirements. H-CR curves for a considerable number of steels were included in the paper, and it was shown that none of the 0.30 carbon steels will meet the requirements of curves 1 and 2 in Fig. 4. Steels 4340, 6145, X3045 and 3145 all meet the requirements of curve 1. Naturally, the cheapest and most machineable of these several steels will be selected, unless fatigue tests on the finished article show it to be inadvisable. Steel 4340, 3240, 3140 and X1340, among others, meet the requirements of curve 2. Core requirements for the case-hardening steel are met completely only by steel 2315, but probably sufficiently by steels 4615 and 4815.

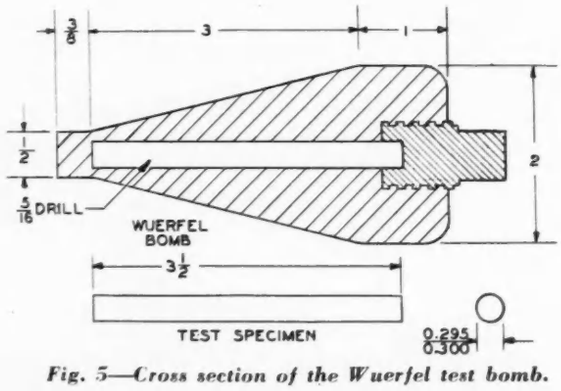


Fig. 5—Cross section of the Wuerfel test bomb.

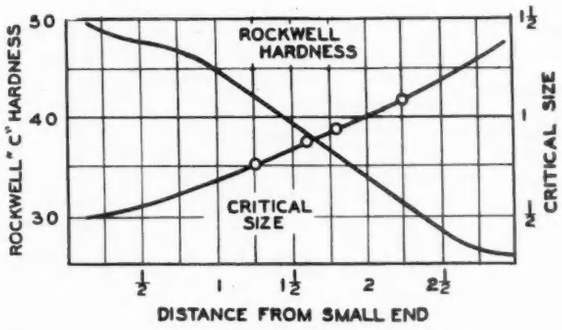


Fig. 6—Variation of Rockwell hardness and critical size with distance from end of test piece at small end of bomb.

THE HARDENABILITY of steel may be determined either by quenching a cylinder in the usual way by immersion, or by quenching it at one end only, in accordance with the Jominy method. In the first method the cross section is examined either visually, or a series of hardness readings are taken. By the second method, hardness readings are taken on the surface of the bar along its length. Both methods are similar in that they show the effects of different cooling rates on the hardness obtained. One limitation of the second method is that the largest test bar which can be machined from a finished part may not have sufficient cross section to develop the desired series of cooling rates. Prior to a recently-published modification, the Jominy method was recommended only for test bars of ⅝-in. diameter and over, and the test still requires the machining of a special "L" type test specimen. In an effort to remove these two limitations, a new method was developed by R. Wuerfel of the Chrysler Corporation and dealt with in a paper by Mr. Wuerfel and F. E. McCleary.

This method makes use of the "bomb" shown in Fig. 5—a cone-shaped piece of steel with a hole through it at the axis. This hole is enlarged at the top, and threaded to take a plug which also provides the handle of the assembled "bomb." The hole is slightly larger than the test piece, and the annular space between is filled with a low-melting alloy, such as Wood's metal, which provides a thermal bridge between the bomb and the test piece.

In use the bomb is warmed above the melting point of the alloy, the required amount is poured in, the test piece is put in place and the plug screwed in. The assembly is then heated to the temperature suited to the steel under test and quenched in water. The assembly is warmed to melt the alloy, and the test piece removed. Hardness readings are taken along the length of the test piece and data are thus obtained for the calculation of "hardenability" as defined by Grossmann and Asimov. Their procedure for calculating the critical diameter gives a rating which may be made common to all other procedures.

The low-melting-point alloy (melting point = 200 deg. Fahr.) contains 50 per cent bismuth, 25 per cent lead and 25 per cent tin. By replacing 5 per cent bismuth by mercury, the melting point may be lowered to 185 deg. Fahr. The steel used in making the bomb contains 0.12 per cent carbon and 0.22 per cent manganese.

By ascertaining on the test piece, the position of the 50 per cent martensite structure and relating it to the critical diameter as determined directly by the Grossmann procedure, the plot in Fig. 6 may be constructed. Thus the longitudinal and cross-sectional positions of equal cooling rate, as determined by the two procedures, are correlated.

Stated in terms of the critical diameter, the results are reproducible within $\frac{1}{8}$ in. The clearance between the test piece and bomb is important, and should be approximately 0.006 in. A spacing of 0.024 in. will change the critical diameter 3/32 in.

The surface of the bomb can be protected best by nickel-plating it and heating in a nearly neutral atmosphere. Quenching has been carried out in a tower, the water being forced in at the bottom at a fixed rate. The details of the quenching system are relatively unimportant. The principal requirements are that the quench should be constant throughout all related tests and that the maximum hardness characteristic of the steel should be approximated at the small end of the bomb.

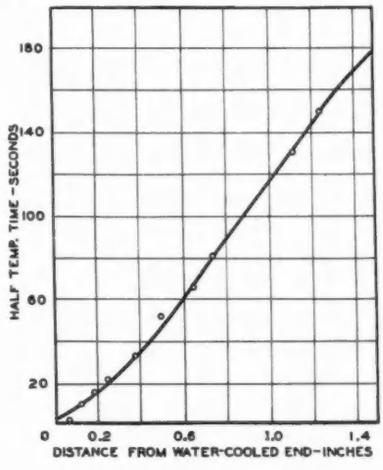


Fig. 7 — Relation between the "half-temperature" time and the distance from the water-quenched end in a Jominy bar.

CORRELATION between results of the Jominy test for hardenability and the hardness of quenched round bars was discussed in a paper by M. Asimow, W. F. Craig and M. A. Grossmann. In the Jominy end-quench test, a cylindrical test piece is quenched on its end with a stream of water of specified velocity, and the resulting hardness is plotted against the distance from the quenched end. In the case of quenched round bars the severity of quench can be ascertained, and the hardness distribution in such bars can be related to the time occupied in cooling in the quench. If, therefore, the cooling conditions in the Jominy quench can be ascertained and related to the cooling conditions in quenched round bars, it should be a simple matter to predict, from the results of a Jominy test, the hardness distribution in round bars resulting from a known severity of quench.

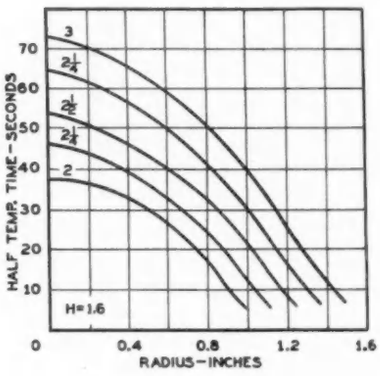


Fig. 8 — Relation between the "half-temperature" time and the distance from the center for round bars of different diameters.

Experiments have shown that the hardening effect correlates well with the time occupied by the steel in passing through one-half the temperature difference between the quenching temperature and the temperature of the quenching medium. Therefore, the "half-temperature" times in a Jominy test, when correlated with the "half-temperature" times for quenched bars, should provide a basis for correlation of the hardening in these two forms of test. In the Jominy test the quenching conditions involve two factors, viz., the cooling effect of the stream of water on one end of the bar, and the cooling effect of still air on the remainder of the bar. The "half-temperature" times resulting from these combined effects are shown in Fig. 7.

It has been shown that the proportionate temperature drop at a particular point after a given time is equal to the product of the proportionate temperature drop due to the water quench alone and that due to the air cooling alone. For instance, if the air cooling alone reduced the temperature to 0.9 its original value and the water quench alone reduced it to 0.6 its original value, then the two combined would reduce it to 0.54 its original value. Half-time temperatures calculated on this basis correlate well with observed values.

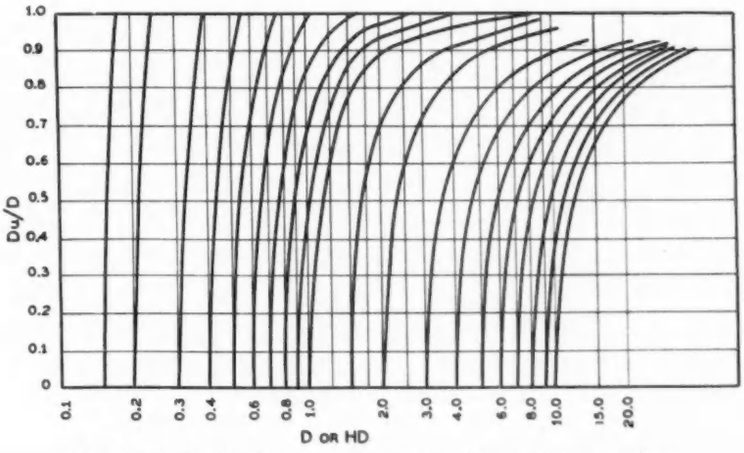


Fig. 9—Relation between the proportionate distance from the center, the product HD, of quench severity and bar diameter, and the bar diameter D.

To compare the half-temperature times shown in Fig. 7 with corresponding values for quenched round bars, it is necessary to know the "half-temperature" times for different points between the surface and the center of the bar for a known severity of quench. The method employed in calculating the "half-temperature" times for the bars is as follows:

Suppose the bar under consideration is a 2-in. round which is quenched with a severity of H = 1.6. It is desired to ascertain the "half-temperature" times for different points between surface and center so that a curve similar to the lowest curve in Fig. 8 can be drawn. Take, for example, the position half-way between center and surface, or 0.5 in. from the center. Since H = 1.6 and D = 2, we have HD = 3.2. In Fig. 9 we locate the value 3.2 on the axis of abscissas, then proceed vertically upward until we intersect the horizontal line corresponding to $D_a/D = 0.50$, which represents the position half-way out from the center to the surface. The point of intersection of the vertical and horizontal lines represents the midway point in a bar of 2-in. diameter, when quenched with a severity H = 1.6. To find the "half-temperature" time for this position we follow the curved lines from the point of intersection downwards toward the left to the axis of abscissas, which latter we cross at 2.7 on the scale of abscissas. This is the HD value for a bar whose center has the same half-temperature cooling time. Since HD = 2.7 and H = 1.6, D = 1.69. From another chart included with the paper it is found that for D = 1.69 and H = 1.6, D_i (the diameter of a bar whose center has the same "half-temperature" time when the quench is infinite) = 2.3. From still another chart it is found that the half-temperature time for D_i = 2.3 is 30 sec. Thus for the point half-way between the center and surface in a 2-in. bar, when the severity of quench is 1.6, the half-temperature time is 30 sec., as indicated by the small circle on the indicated curve in Fig. 8.

It was found that the "half-temperature" time results in a certain hardness, whether it be encountered in the Jominy bar or in a quenched round; hence the position in the Jominy bar which has a certain cooling-time should exhibit the same hardness as the position in a round bar which has the same cooling-time (when using the same steel).

O. V. GREENE and C. B. Post of the Carpenter Steel Co., metallurgical department, contributed a paper in which they held that the hardenability of shallow-hardening steels can be measured by means of a taper test specimen. This test specimen consists of a round bar with a 1.5 taper. In the experimental work done by them they used specimens measuring 5 in. in length and ¼ in. and 1¼ in. in diameter at opposite ends.

This taper test specimen has been correlated with the cooling velocities published for the Jominy type "L" bar. This enables the taper test specimen to give specific hardenability in terms of a critical cooling rate (in. deg. Fahr. per sec.) at 1300 deg. Fahr.

The taper test specimen has been correlated with the work of Grossmann and his associates on "critical bar diameters" and severity of quench. It has been shown experimentally that the taper test specimen behaves (within the experimental error) like a series of round bars whose diameters are given by twice the perpendicular distance from the surface of the taper test specimen to any point along the central axis. This enables the severity of quench to be evaluated by the methods proposed by Grossmann and his associates, and also enables approximate calculations to be made concerning the penetration to be expected in any given sized round bar.

IN A PAPER entitled "Properties of Some Synthetic Rubbers," L. B. Sebrell and R. P. Dinsmore of the Goodyear Tire & Rubber Company first traced the history of synthetic rubber-like compounds from their beginning and then turned to the properties of the various compounds now in production. They quoted Stoecklein's division of highly-polymerized rubber-like materials into two general classes, as follows:

1. Synthetics capable of vulcanization:

a. Butadiene co-polymers.

b. Reaction products of dihalogenated aliphatic compounds with sodium polysulfide.

2. Synthetics incapable of vulcanization:

a. Polymerized isobutylenes (similar to Vistanex) of polymerized acrylic acid esters (similar to Plexigum and like materials).

b. Products having rubber-like properties in combination with certain plasticizing agents (as, for example, Koroseal).

The authors confined themselves to a discussion of types falling in the first class. These rubbers have been compounded into two main types of formulae: (1) a formula containing approximately 40 parts of hard carbon black and giving a rubber stock of the type usually used in tire treads; and (2) a formula containing 50 parts of soft carbon black and being, in general, representative of the formula which would be used in mechanical goods.

While all synthetic rubbers possess elasticity and resilience, they differ very considerably in their molecular make-up, and it should therefore not be expected that they can be processed in the same way as natural rubber has been processed for many years.

Each synthetic rubber constitutes a different chemical compound. They are similar only in certain superficial properties. In regard to some of their properties, as, for example, resistance to solvents such as gasoline, benzene, and lubricating oil, some of the synthetic rubbers are very much better than natural rubber. Some, when properly fabricated into a tire, have been found to show superior abrasion resistance to that of natural rubber. In other properties, such as resistance to very low temperatures and tackiness, they are sometimes quite deficient.

We should look upon synthetic rubber, not as a material which can be universally substituted for the natural product, but as a material having special properties which, when properly handled, will give improved results as compared with natural rubber. On the other hand, we should look upon it as a material whose development and perfection will liberate us from the threat of embargo of natural rubber during the time of national emergency and as a guarantee that the

(*Turn to page* 81, *please*)

New Passenger Car Registrations

	NOVEMBER 1940	OCTOBER 1940	NOVEMBER 1939	ELEVEN MONTHS 1940	ELEVEN MONTHS 1939	Per Cent Change, 11 Months 1940 over 1939	Per Cent of Total Eleven Months 1940	Per Cent of Total Eleven Months 1939	TWO MONTHS MODEL YEAR 1941	TWO MONTHS MODEL YEAR 1940	TWO MONTHS MODEL YEAR Per Cent Change
Chevrolet	72,011	71,689	59,520	764,533	533,522	+ 43.4	24.81	22.17	143,700	84,766	+ 69.5
Ford	48,412	41,761	46,005	489,935	436,211	+ 12.2	15.90	18.12	90,173	80,505	+ 12.0
Plymouth	37,452	41,517	11,772	402,472	331,932	+ 21.3	13.06	13.79	78,969	49,338	+ 60.2
Buick	27,951	32,283	26,863	266,755	194,410	+ 37.1	8.66	8.08	60,234	50,385	+ 19.6
Pontiac	23,817	22,576	17,741	210,672	141,328	+ 49.0	6.84	5.87	46,393	31,921	+ 45.1
Dodge	15,785	10,273	3,570	179,668	166,809	+ 7.8	5.83	6.93	26,058	17,343	+ 50.0
Oldsmobile	19,887	18,627	16,780	179,516	129,615	+ 38.6	5.83	5.39	38,514	29,968	+ 28.2
Studebaker	8,057	10,113	8,741	93,534	76,238	+ 22.8	3.04	3.17	18,170	17,317	+ 5.0
Chrysler	9,702	6,486	2,184	88,696	60,262	+ 47.1	2.88	2.50	16,188	8,367	+ 93.5
Hudson	6,058	8,044	8,671	73,752	55,184	+ 33.8	2.39	2.29	14,102	16,911	− 16.6
Mercury	6,996	4,759	6,661	72,573	58,416	+ 24.2	2.36	2.43	11,755	10,982	+ 7.0
Packard	5,813	7,046	7,969	68,116	55,147	+ 23.6	2.21	2.29	12,859	16,255	− 21.0
De Soto	6,102	4,820	2,019	64,949	49,037	+ 32.6	2.11	2.04	10,922	6,746	+ 62.2
Nash	4,427	2,534	4,844	46,689	49,273	− 5.1	1.52	2.04	6,961	9,127	− 23.8
Willys	1,783	1,418	2,107	19,773	12,917	+ 53.2	.64	.54	3,201	3,971	− 19.4
Lincoln	1,787	1,859	1,903	19,187	17,817	+ 7.5	.62	.74	3,646	3,174	+ 15.0
Cadillac	4,391	3,590	1,267	16,733	11,611	+ 44.0	.54	.48	7,981	2,227	+258.0
La Salle	157	381	2,736	16,471	19,731	− 16.6	.53	.82	538	4,277	− 87.4
Graham	180	201	60	1,706	3,612	− 52.7	.06	.15	381	202	+ 89.0
Bantam	29	44	.....	774	.....	.....	.03	.....	73	.....	.....
Crosley	31	48	.....	400	.....	.....	.01	.....	79	.....	.....
Hupmobile	46	40	13	179	900	− 80.2	.....	.04	86	33	+160.0
Miscellaneous	556	386	145	3,936	2,861	+ 37.6	.13	.12	942	342	+175.0
Total	301,430	290,495	231,571	3,081,016	2,406,833	+ 28.0	100.00	100.00	591,925	444,157	+ 33.5
Chrysler Corp.	69,041	63,096	19,545	735,782	608,040	+ 21.0	23.88	25.26	132,137	81,794	+ 61.6
Ford Motor Co.	57,195	48,379	54,569	581,695	512,444	+ 13.3	18.88	21.29	105,574	94,661	+ 11.5
General Motors Corp.	148,214	149,146	124,907	1,454,680	1,030,217	+ 42.1	47.22	42.81	297,360	203,544	+ 46.1
All Others	26,980	29,874	32,550	308,859	256,132	+ 20.6	10.02	10.64	56,854	64,158	− 11.4

New Truck Registrations

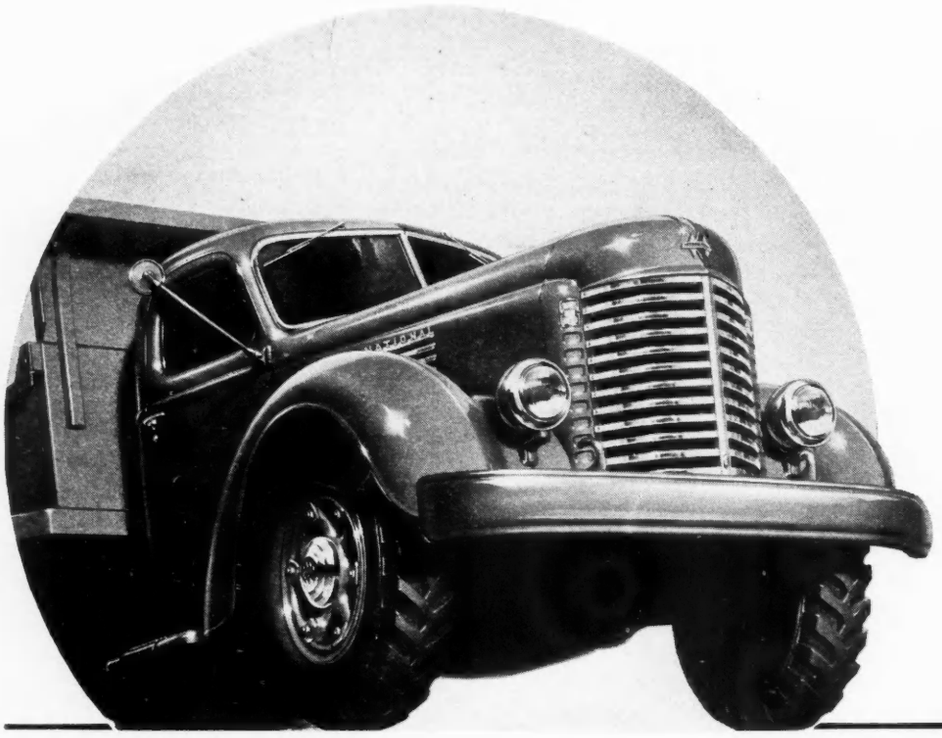
	November 1940	October 1940	November 1939	ELEVEN MONTHS 1940	ELEVEN MONTHS 1939	Per Cent Change, 11 mon hs 1940 over 1939	Per Cent of Total Eleven Months 1940	Per Cent of Total Eleven Months 1939
Chevrolet	15,990	14,901	14,879	174,899	155,744	+ 12.2	33.30	34.67
Ford	14,264	14,380	12,312	147,549	117,357	+ 25.6	28.09	26.13
International	5,335	7,755	5,160	72,245	61,115	+ 18.0	13.76	13.60
Dodge	3,995	3,928	2,443	50,433	46,189	+ 9.0	9.60	10.28
G. M. C.	3,356	3,212	3,383	39,009	32,137	+ 21.3	7.43	7.15
Plymouth	627	588	364	8,804	7,985	+ 10.1	1.68	1.78
Mack	760	842	599	7,124	6,162	+ 15.6	1.36	1.37
White	839	588	406	6,443	4,271	+ 50.8	1.23	.95
Diamond T	459	601	522	5,950	4,904	+ 21.3	1.13	1.09
Willys-Overland	121	172	162	2,184	1,460	+ 49.1	.42	.32
Autocar	156	429	157	1,806	1,938	− 7.0	.34	.43
Brockway	171	247	154	1,537	1,694	− 9.2	.29	.38
Divco	87	126	169	1,500	1,332	+ 12.5	.28	.30
Federal	121	140	217	1,483	1,635	− 9.2	.28	.36
Studebaker	45	109	150	1,085	2,024	− 46.3	.21	.45
Hudson	62	49	5	686	371	+ 85.0	.13	.08
Reo	103	104	8	531	845	− 37.0	.10	.19
Bantam	4	9	52	331	553	− 40.1	.06	.12
Sterling	37	29	28	313	308	+ 1.5	.06	.07
F. W. D.	14	26	20	237	166	+ 42.8	.05	.04
Miscellaneous	72	121	91	1,060	1,098	− 3.4	.20	.24
Total	46,618	48,356	41,286	525,209	449,288	+ 17.0	100.00	100.00

New Registrations of Passenger Cars and Commercial Vehicles continue to Increase

New Passenger Car Registrations and Estimated Dollar Volume by Retail Price Classes*

PRICE CLASS	NEW REGISTRATIONS NOVEMBER Units 1940	Units 1939	Per Cent of Total 1940	Per Cent of Total 1939	NEW REGISTRATIONS ELEVEN MONTHS Units 1940	Units 1939	Per Cent of Total 1940	Per Cent of Total 1939	ESTIMATED DOLLAR VOLUME NOVEMBER Dollar Volume 1940	Dollar Volume 1939	Per Cent of Total 1940	Per Cent of Total 1939	ESTIMATED DOLLAR VOLUME ELEVEN MONTHS Dollar Volume 1940	Dollar Volume 1939	Per Cent of Total 1940	Per Cent of Total 1939
Chevrolet, Ford and Plymouth	157,875	117,297	52.47	50.66	1,656,940	1,301,665	53.84	54.10	$128,300,000	$89,400,000	46.08	43.77	$1,282,358,000	$959,700,000	47.45	46.73
Others under $1,000	54,053	78,304	17.97	33.82	897,495	856,103	29.17	35.57	50,100,000	71,200,000	17.99	34.86	813,447,000	782,200,000	30.10	38.09
$1,001 to $1,500	83,976	33,097	27.91	14.29	496,208	213,947	16.13	8.89	91,300,000	38,200,000	32.79	18.71	556,351,000	248,000,000	20.59	12.08
$1,501 to $2,000	3,911	2,084	1.30	.90	18,652	22,741	.61	.95	6,200,000	3,600,000	2.23	1.76	31,261,000	35,600,000	1.16	1.73
$2,001 to $3,000	1,052	740	.35	.32	7,701	11,007	.25	.46	2,500,000	1,700,000	.90	.83	18,589,000	25,000,000	.69	1.22
$3,001 and over	7	31	.....	.01	84	676	.....	.03	30,000	150,000	.01	.07	400,000	3,000,000	.01	.15
Total	300,874	231,553	100.00	100.00	3,077,080	2,406,139	100.00	100.00	$278,430,000	$204,250,000	100.00	100.00	$2,702,406,000	$2,053,500,000	100.00	100.00
Miscellaneous	556	18	.....	.....	3,936	694	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	301,430	231,571	100.00	100.00	3,081,016	2,406,833	100.00	100.00	$278,430,000	$201,250,000	100.00	100.00	$2,702,406,000	$2,053,500,000	100.00	100.00

* All calculations are based on delivered price at factory of the five-passenger, four-door sedan, in conjunction with actual new registrations of each model. The total dollar volumes are then consolidated by price classes.



NEW

The new IHC offerings take on a new appearance with models ranging from 10,000 to 18,000 lb. capacity.

FIVE new heavy-duty truck models announced by the International Harvester Company have such features as easier steering, new styling, foam-type sponge-rubber seat cushions, easier-riding springs, frames of improved design, rubber-mounted propeller-shaft center bearings, new engine details, Hi-Tork hydraulic brakes, improved vacuum brake-actuating cylinders, and larger, quicker-acting air-brakes.

Carrying capacities of the new models—cab, body, equipment, and payload—range from 10,000 to 18,000 lb., and gross vehicle weights from 14,500 to 27,000 lb. Model K-6 has a carrying capacity of 10,000 lb.; Model K-7, 11,000 lb.; Model K-8, 12,000 lb.; Model K-10, 14,500 lb., and Model K-11, 18,000 lb.

Models K-6 and K-7 are available in wheelbases from 134 to 176 in.; Model K-8, from 137 to 197 in., and Models K-10 and K-11, from 149 to 197 in.

The five new models are powered by five sizes of six-cylinder, valve-in-head, replaceable liner engines, ranging from a 241-cu. in. engine developing 84 hp. at 3200 r.p.m., to a 401-cu. in. engine developing 114.2 hp. at 2600 r.p.m. Torques range from 175.5 to 308 lb.-ft. at 800 r.p.m.

On Models K-8, K-10 and K-11 the steering effort required has been reduced by more than one-half and the improvement on the other models is said to be nearly as great. To achieve these improvements, the king-pin inclination was reduced from 8 to 4 deg., twin-lever steering gears were adopted which give a higher leverage, and all models were fitted with ball bearings at the upper end of the steering post, while Models K-8, K-10 and K-11 have the twin levers in the steering gear mounted in tapered roller bearings.

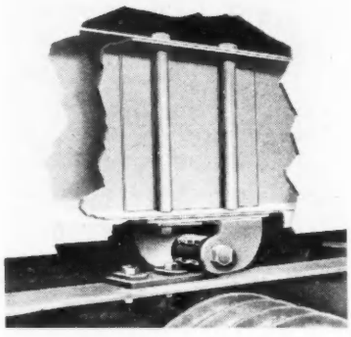
Sweeping lines in radiator grille, fenders and hood give these new models a streamlined, distinctive appearance quite similar to, but more massive than that of the recently introduced International Models K-1 to K-5. Head lamps are of the sealed-beam type. Parking lights are built integral with the grill, to harmonize with the streamlining. There is no bright metal on top of the hood to reflect sunlight.

The fenders are more than 10 per cent heavier, and all running boards have a molded-rubber step plate with a ribbed surface that protects the running board paint and also prevents the driver from slipping when entering or leaving the cab. The front bumper is of channel steel and serves as an additional crossmember of the frame. Between the bumper and the grille and fenders is a sheet-steel splash shield and stone guard which also may be used as a step when servicing the engine. The new type of telescoping hood support is provided with an automatic latch.

The new cabs have more leg room and head room, and also improved vision. A foam-type sponge-rubber seat cushion is standard equipment. The rubber extends from top to bottom of the cushion and has vertical, pillar-shaped air spaces providing room for the rubber displaced by the driver's weight to flex without hugging the driver and causing him discomfort. The seat is adjustable forward and back, and the back cushion has an adjustment for tilt, independent of the seat adjustment. The cab is supported at three points by means of rubber-insulated trunnion mountings, two at the front corners and one centrally at the rear. They are designed to prevent cab side movement

INTERNATIONAL

Heavy-Duty Truck Models



Cabs are three-point mounted on new rubber - insulated hinged joints.

and twist, and to keep the driver from being pitched from side to side on rough roads.

Other new cab features include high-test safety glass, a new instrument panel, a headlight-beam indicator in the instrument panel, and a felt-base rubber floor mat with a sweep-out pattern which facilitates sweeping out dirt and dust.

Front springs are from 3⅝ to 7½ in. longer, and their capacities have been increased 10 per cent or more. Rear springs of the smaller two models also have been increased in length.

The front crossmember of the frame is wider and deeper, giving added frame strength and providing space for an improved rubber mounting for the radiator. The engine is mounted on rubber at one point in front and at two points in the rear. The new propeller-shaft center bearing has tapered roller bearings and a rubber ring between the bearing housing and the crossmember.

Fuel pumps are now mounted on the left-hand side of the engines, away from the heat of the exhaust manifold. The water pump has a mechanical seal which requires no adjustment. Other new engine features include a distributor of larger diameter; "universal heat range" spark plugs; and—in engines for Models K-8, K-10, and K-11—a combination carburetor and governor.

A variety of rear-axle types are available for these International models. Spiral-bevel, double reduction, and two-speed rear axles with proper gear ratios provide the necessary speed and power for both highway and off-the-road service. Hi-Tork hydraulic brakes are used on the rear wheels of Models K-6 to K-10, inclusive. Conventional Lockheed-type two-shoe double-anchor brakes are used on the front wheels, where less braking effort is required.

Brake drums on all four wheels are of new design. A reinforcing rib, located near the center of the brake, adds to the rigidity of the drum and reduces noise. It also provides room for a new type of self-cleaning slinger which keeps dust and water out of the brake. In addition, the back of the drum has a heavier section and the drum mounting flange is close to the brake, giving added rigidity. A vacuum power unit is standard equipment on the hydraulic braking systems of these heavy-duty trucks. Air brakes are regular equipment on Model K-11 and are available for Models K-7, K-8, and K-10 using a foot treadle instead of a pedal.

Automotive Materials

(*Continued from page* 78)

price of the natural product will never again reach the peaks which have characterized it in the past.

The artificial rubbers for which test data were given in the paper included the Neoprene types, the Buna types, Thiokol, Chemigum and the Hycar synthetic rubber manufactured by Goodrich. The compounding properties of Neoprene and Thiokol are generally well understood. Chemigum and Hycar are new types of synthetic rubber which in general have the same properties as Buna rubber. Quantitative values were given in the paper for the extrusion plasticity, the tensile strength, elongation, modulus at 300 per cent elongation, durometer hardness, rebound resilience, flexing, volume increase in X-70 gasoline in 12 days, and Grasselli abrasion loss for the tread compound and the tensile strength, elongation, Shore hardness, volume increase in X-70 gasoline in 12 days and in benzol in 12 days, and of the dynamic resilience and pendulum rebound for the mechanical goods compound.

S.A.E. Annual Meeting

As is recorded in a news report printed on another page of this issue, the Annual Meeting of the S.A.E. held in Detroit, Jan. 6 to 10 was one of the largest ever held by the Society. The keynote of the program, national defense, ran through the papers and discussions. The armed forces of the country were represented by top ranking officers who presented the Government's needs, hopes and expectations.

The talks by Major Generals E. B. Gregory and C. L. Scott emphasized the need for freezing standardized designs for motorized military equipment in keeping with the requirements of mass production techniques. The theme at the moment is consistent standardization, simplification of units, reduction in the number of different attachments and accessory items, full interchangeability of parts and units wherever feasible.

In discussing the problems of the motorized force of the Army, General Scott commented on the urgent need for greater structural strength and longer life in military motorcycle equipment. In his opinion the midget cars which have been discussed recently will find a definite and important place and in all probability will displace much existing tricycle equipment. The importance of the Diesel engine for tanks has been given great prominence due to the more than doubling of the cruising radius of vehicles so equipped.

Dr. Gillette of The Battelle Memorial Institute described the practical possibilities of finding substitutes for raw materials of strategic importance in the National Defense Program. He served notice on belligerent countries, in no unmistakable terms, that the United States is prepared to go ahead on an almost self-sufficient basis without establishing long lines of communication in the event that the sources of strategic materials were to be blockaded or otherwise restricted. He showed that our metallurgists could solve such problems by an intensive utilization of the low grade ores at the necessary premium of increased production expense.

Abstracts of many of the papers presented are printed here. Others are to be found in the Aviation and Materials Section of this issue. Still others will appear in later issues.

Improvement in Mixture Ratios

The air-fuel mixtures used in automobile engines represent the engineering compromise that must be made between the relatively lean mixtures which are desirable from the standpoint of fuel economy, and the richer ones which are necessary because of inherent imperfections in commercial induction systems. One of these factors, the maximum-economy mixture, will hardly change with time, at least not appreciably, but the other one, the rich mixture which must be used because of imperfections in equipment, will undoubtedly change as these imperfections are reduced or eliminated. A survey of the compositions of mixtures actually received by automobile engines over a wide speed range, during a period of 13 years, was made by G. W. Lovell, J. M. Campbell, B. A. d'Alleva and P. K. Winter of G.M. Research Laboratories Division, and was made the basis of a paper presented by them at the session.

The authors said there is considerable evidence that under ideal conditions the mixture ratio for maximum power is close to chemically correct ratio for complete combustion. With this ratio, which is about 15 to 1 for average commercial gasoline, the fuel can burn substantially completely to carbon dioxide and water. The maximum-economy mixture is generally taken to be somewhat leaner than this. That mixtures richer than 15 to 1 must be used under certain conditions is accounted for by the facts that qualitative distribution to the different cylinders is not uniform, that the mixture richness in a given cylinder varies from cycle to cycle, and that there may be stratification of the charge in the cylinder.

Three surveys of actual mixture proportions were made, on 1927, 1933 and 1940 cars, respectively. In each case a group of cars was experimented with, varying from six to 12, the mixture ratios used in them being determined both at full load and under road-load steady driving conditions over the whole

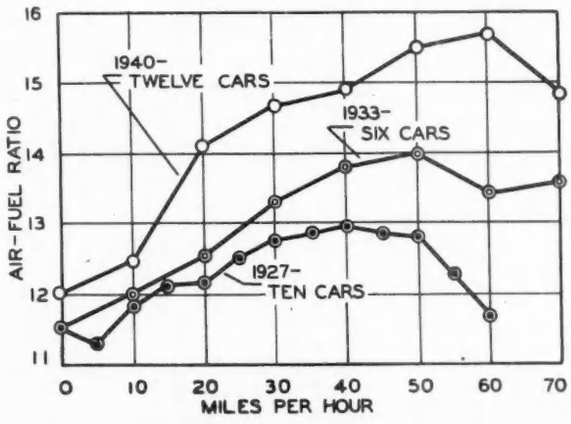


Fig. 1—Average mixture ratios at road loads.

National Defense is keynote of the program with wide scope of subjects

speed range. Mixture ratios in all cases were determined by exhaust-gas analysis.

Fig. 1, herewith, shows the average mixture ratio at road load over the whole speed range for each of the three groups of cars. It shows that there has been consistent improvement in this respect during the

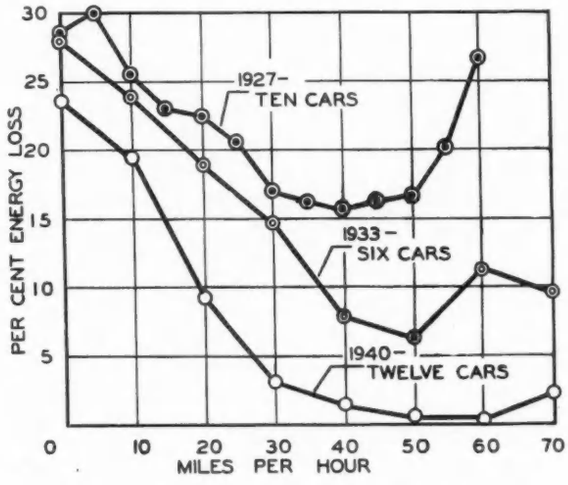


Fig. 2—Average energy losses at road loads.

two time intervals. In all cases the mixture is richer at low speeds, when the qualitative distribution is most likely to be poor. Fig. 2 shows the average energy loss at road load due to variations of the mixture ratio from the ideal, over the speed range. The authors in the paper explained how they figured this energy loss from the mixture ratio. They showed that there is a straight-line inverse relation between the per cent loss and the mixture ratio. The graph given by them can be represented very closely by the equation

$$\text{Loss} = .9\ (14.6 - r),\ \text{per cent},$$

where r is the mixture ratio.

Rose Engine Indicator

THE ROSE indicator, developed by Prof. R. A. Rose at the University of Wisconsin, and described by Prof. G. C. Wilson, permits of recording simultaneously variations in as many as five factors connected with combustion in an engine cylinder. As now set up in the Heat-Power Laboratory of the University, the system (see diagram) consists of (A) a multiple pick-up and amplifying apparatus, (B) a three-tube cathode-ray oscillograph, (C) a revolving-drum camera, and (D) a dead-center indicator.

For the purpose of recording the movements of the injector valve, the movable part of a light shutter is fastened directly to the needle valve thereof. A concentrated-filament light source is placed on one side of the shutter and a photo cell on the other. The photo-cell connects to a direct-coupled amplifier, which has an instantaneous output that is directly proportional to the lift of the valve.

Another photo-cell is energized by the combustion radiation, a fused-quartz window being installed in the side wall of the combustion chamber of the engine directly beneath the fuel injector and on a level with the center of the chamber. The pressure indicator consists of an RCA quartz-crystal (piezo-electric) pick-up and its amplifier. A separate 5-in. cathode-ray

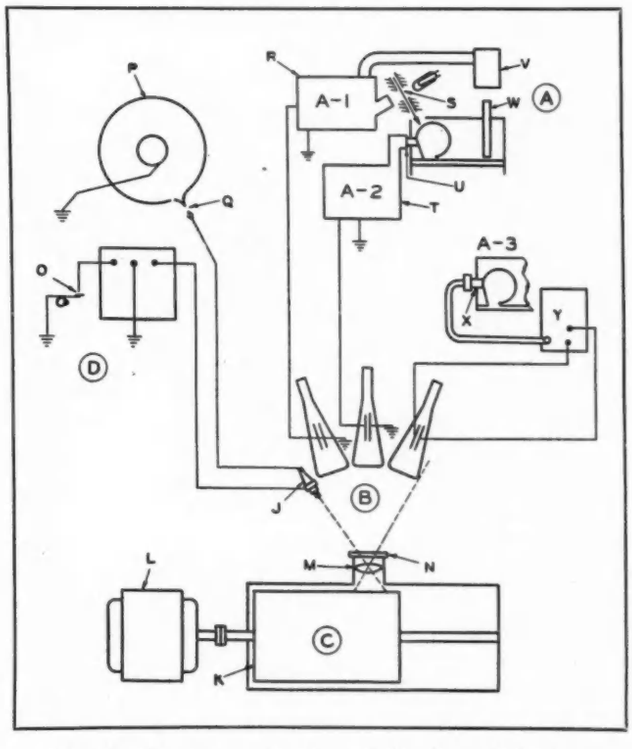


Fig. 3—Diagrammatic view of the Rose Indicator.

J Spark plug
K Sliding film drum 3 ft. circumference carries 20 x 24 in. film
L Synchronous motor 1200 r.p.m.
M 3 in. f/1.5 lens
N Shutter
O Breaker points
P Engine flywheel—24 in. dia.
Q Rotary air gap
R Fuel injection phototube and amplifier
S Light shutter
T Radiation phototube and amplifier
U Separate chamber window
V Phototube
W Main chamber window
S Quartz crystal
Y RCA amplifier

NEW DEVELOPMENTS

tube is connected to the amplifier of each of the three pick-up systems described, the three screens facing the lens of the camera. On these screens the beams deflect horizontally in the same plane with the axis of the camera drum. The action of the beams on the screens is retained photographically on the film in the revolving-drum camera.

The fourth unit of the system serves to indicate the exact top-center point on the revolving film. On the engine camshaft are mounted breaker points which are adjusted so that a spark coil is energized a few degrees before engine top center. The output from this coil passes through a Type-866 rectifier tube and then to a small condenser which is in series with a spark plug and a rotary air gap on the engine fiywheel. This condenser can discharge only when the rotary air gap is at its minimum, and this gap is adjusted so that the minimum value occurs exactly at top center. The spark plug is mounted near the cathode-ray screens, where its discharge is recorded as a dot on the revolving film.

Wide-Base Rims for Passenger-Car Tires

A SYMPOSIUM on wide-base rims for passenger-car tires was held under the chairmonship of E. H. Smith, representatives of U. S., Goodrich, Goodyear and Firestone contributing papers. R. D. Evans of the Goodyear Tire & Rubber Co., pointed out that the conception of a wide-base rim is not new by any means, a patent on a rim with a base as wide at the tire having been granted as far back at 1915. It did not prove successful, however. By 1925, when the use of balloon tires on passenger cars had become common, rim widths (measured between the vertical flanges) had become fairly well standardized at 50 per cent of the width of tires mounted on them. This proportion between rim width and tire width was continued for seven or eight years, and seemed to be generally satisfactory for tires and automobiles as manufactured during that period.

In 1933 the so-called low-pressure balloon tires came into use. Rims with a base width equal to 65 per cent of the tire width were recommended for these tires. The reason for this 30-per cent increase in rim width was that it tended to neutralize the increase in tread wear and deterioration in car-handling qualities due to the low inflation pressures used in these tires. Some engineers favored still further increases in rim width, and they were responsible for the inclusion in the Tire & Rim Yearbook, to an increasing extent from 1933 to 1940, of recommendations for alternative rim widths of up to 73 per cent of the tire widths.

It appears that during 1940 there has been a sort of cooperative study, participated in by tire makers and car manufacturers, of the effects of changes in rim width on various performance factors. It has long been known that an increase in the width of a rim (for a tire of given size) increases the lateral stability and the cornering power of the tire, but at the same time it reduces the radial flexibility. It, therefore, has the same effect as an increase in the inflation pressure, and this makes it possible to express some of the effects of a widening of rim bases in terms of an increase in inflation pressure. Mr. Evans' paper included a table showing the dependence of tread life on rim width and inflation pressure. Calling the tread life with a 65 per cent rim width and 28 lb. pressure 100 per cent, the life with 70 per cent rim width and the same pressure is 114 per cent, with 75 per cent rim width and 27 lb. pressure, 119 per cent, and with 80 per cent rim width and 26 lb. pressure, 122 per cent.

These figures were averaged from results obtained with three tire sizes, six different cars of three different makes, on routes with all sorts of topography, and with tires either kept in the same position on the car or rotated between the four wheels.

Wider rims make the car more stable in operation, or free from "wander," and the results indicated that a 1-in. increase in rim width is roughly equivalent to an increase of 1.5 lb. in the inflation pressure in this respect. This may be compared with the effect on stability of an increase in the tire size, from 6.00 to 6.50 in., which was found to be roughly equivalent to an increase of 6 lb. in the inflation pressure.

The beneficial effects of wider rims are partly offset by accompanying disadvantages. Widening the rims makes the car harder riding, and an increase in the proportional rim width from 65 to 80 per cent is roughly equivalent to an increase of 3 lb. in the inflation pressure in this respect. This is the reason why lower inflation pressures are generally used in tires on wide-base rims. Also, with the wider rim the flange may be more exposed to curb damage, because it is less protected by the bulge of the tire side wall.

E. A. Roberts of Firestone was rather enthusiastic regarding the advantages of wide-base rims. He claimed that on rims 1½ in. wider than standard (see drawings), the non-skid tread wear mileage is increased by from 5 per cent for easy conditions to 80 per cent for hard-driving conditions, the improvement averaging 20 per cent. Fabric life of wide-rim tires was equal to that of standard tires, and satisfactory. The strain on beads is greater with wide-base rims and it was necessary to develop new flanges providing greater support. He said it is impossible to blister the side wall of a wide-rim tire and difficult to bruise-break the tire, but it is easier to damage the rim. The effect of the increased stability of the wide-rim tire is especially evident in improved cross-wind handling.

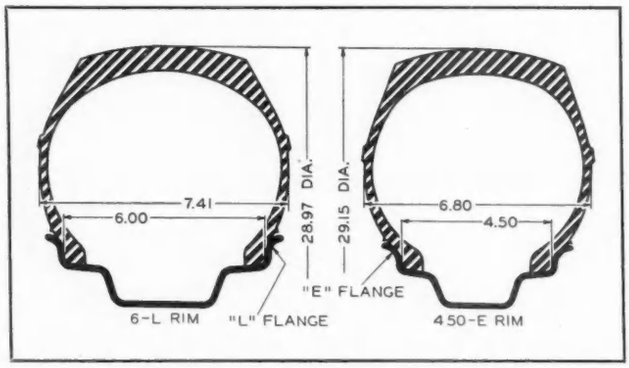


Fig. 4—Sections showing features of wide and narrow rim.

Engine Design for Effective Lubrication

IN THE development of engine design, specific outputs have been boosted so much that a good deal of trouble with bearings and lubrication is being experienced, and the "grief" usually comes home to the lubricant manufacturer. According to R. J. S. Pigott, of the Gulf Research & Development Co., who read a paper on "Engine Design vs. Engine Lubrication," "for some 60 or 65 years of petroleum lubricants, we were able to lubricate all machinery with reasonable success by using nothing but straight mineral oils and fuels,

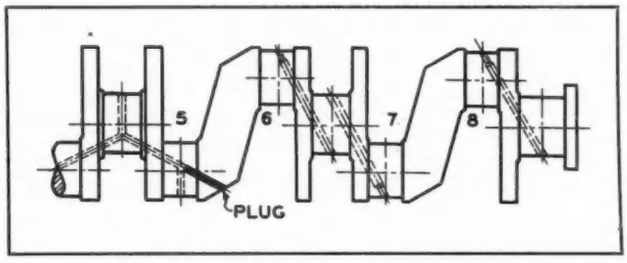


Fig. 5—Rear half of eight-throw crankshaft, showing oil holes.

and the various devices were designed to run on these materials. But in the last five years, a very considerable and undesirable change has occurred; mineral oils increasingly showed distress in modern designs, and it was apparently assumed that the only recourse was to 'improve' the oil by the addition of various dopes, inhibitors, vegetable and animal oils, and what not. 'Oiliness,' that ghostly quality, has come in for a considerable play; 'film strength,' another manifestation from the occult, is in everybody's mouth."

Mr. Pigott maintained that in many cases when there is trouble with engine bearings it is due to the fact that not enough oil reaches the bearings to meet cooling and lubrication requirements, and he proposed calculating the actual rates of flow to each of the different bearings under particular conditions of speed and operating viscosity. Only two assumptions are necessary for such a calculation, viz., the eccentricity ratio of the bearings and the average temperature in the bearings above the crankcase-oil temperature. A study showed that a constant eccentricity ratio of 0.9 could be used without material error. The average temperature above crankcase was assumed for calculating the flow and compared with the capacity for heat removal; usually a second approximation gave the right answer.

In a particular eight-cylinder engine, connecting-rod bearings Nos. 4 and 5, Fig. 5, were fed from a single main bearing, and the control orifices (0.152 in. in diameter) were 6.5 times as long as the others. This restriction, of course, resulted in considerable loss of pressure, and the remaining inlet pressure, after loss to the connecting-rod bearings, was lowest for bearings Nos. 4 and 5. The triangular dirt grooves, shown in Fig. 6, robbed the bearing surface of most of its oil supply. According to the author's figures, only 3 to 7 per cent of the oil actually supplied to the bearing was used for lubrication and cooling, the remainder being thrown out without assisting in these important functions. While the 0.152-in. orifices were designed to control the oil flow, these were only part of the total resistance to flow, and calculation showed that the bearing clearance was the controlling factor. With an S.A.E. 30 high-viscosity-index oil the operating temperature of the center bearings reached the very high maximum figure of 402 deg. Fahr., and with S.A.E. 20 low-viscosity-index oil, 359 deg. Fahr. With the latter the operating viscosity is lower, and this results in the lower temperature. In an actual test at 3500 r.p.m., bearings Nos. 4 and 5 failed first.

The following year the bearing shells were changed by omitting the annular groove but retaining the transverse dirt groove. This reduced the by-passing of oil from about 97 per cent to a very small value, hence the total flow in that part of the system up to this point was considerably reduced; the pump relief valve was set to hold the pressure at 50 instead of at 35 lb. per sq. in. This increased the oil flow more than 60 per cent, and the bearings gave no further trouble.

The author remarked that the omission of the annular oil groove probably was a convenient move from the production standpoint, but tests disclosed that bearings with such a grove have much higher load capacity than bearings with single-point feed, probably because at the same supply pressure the oil flow is much greater. If the dirt groove is required, it can be made harmless by changing from a triangular groove as shown in the drawing, to a land 0.03125 to 0.0625 in. wide and 0.002 to 0.003 in. deep on one edge of each shell. This groove, the author said, will carry off only 5 to 10 per cent of the total oil supply, instead of 95 per cent.

As to what can be accomplished with straight mineral oil when the mechanical design is right, the author mentioned that in a racing engine developing more than 275 b.hp. at 7000 r.p.m., babbitt is perfectly satisfactory at loads of 3148 lb. per sq. in. peak and 2015 mean. But 14 gals. is circulated through the bearings per minute, the crankcase temperature is 160 deg. to 180 deg. Fahr., an external cooler being used, and the bearing temperature is not over 230 deg. Fahr.

Two years ago a small aircraft engine gave bearing trouble. Originally a ball bearing had been used in

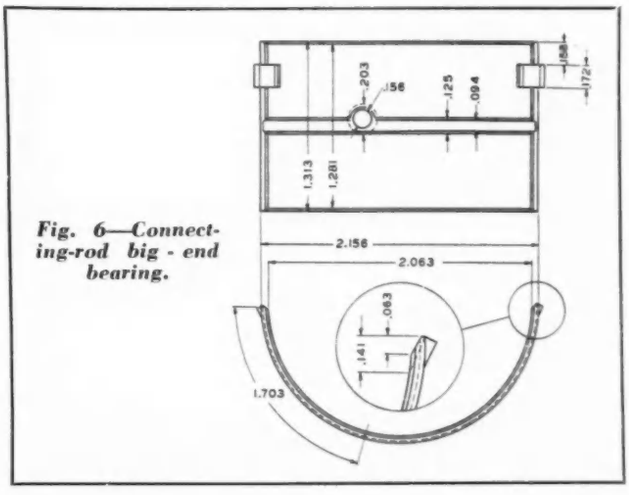


Fig. 6—Connecting-rod big-end bearing.

the connecting-rod big end, and this was replaced by a sleeve bearing in the same space. The crankpin oil hole was drilled on the inside of the throw, where the clearance was the minimum for most of the revolution, and there was no annular groove. Consequently the bearing was starved. The results were too low oil flow to carry off the heat, too high oil temperature, rapid oil breakdown, bearing trouble, and a dirty engine.

Motor Coach Design

MORE PROGRESS in the development of vehicle structures has been made by designers of motor coaches than by those of any other type of vehicle, said Merrill C. Horine and Harry S. Bernard of Mack Trucks, Inc., in a paper on "Structural Developments in Motor Coach Design." The incentive to this rapid progress, they asserted, is that motor buses are operated on a slender margin between earnings and costs, the inference being that there must be a profit for the operator or the market for motor coaches will vanish. What favored rapid progress in design is the fact that variations in operating conditions are not nearly as great as those met with in truck operation, for example.

Because the incentive toward improved design was high, motor bus powerplants have reached a high degree of reliability, automatic transmissions were adopted in the bus field earlier than in any other, rear mounting of powerplants received its first exemplification in buses, and the unified chassis and body structure also has found much wider application in the bus field than in any other.

In the typical transit bus of 1941, a box-girder structure provides the maximum vertical rigidity for a given weight, thereby reducing stresses. There is a growing tendency, moreover, to make some of the elements of this structure serve multiple purposes. Development of bus bodies or structures has to a certain extent followed or paralleled similar development in aircraft structures. The alloy-steel tubing skeleton with non-stressed aluminum skin construction was developed experimentally on both bus bodies and planes at about the same time, while modern stainless-steel structures were fairly well developed for truck, bus and railcar bodies before they were seriously considered in airplane design.

In the development of a new bus model events usually take the following course: Almost before the first samples are delivered, alterations and additions to the equipment are necessary to conform with new regulations, etc., changes which inevitably add weight. Then, as operating experience accumulates, unexpected deflections occur, often resulting in panel cracks, vibration—sometimes failure of structural parts. Such occurrences, of course, are met by strenuous campaigning of existing jobs, followed by a thoroughgoing course of reinforcing, increasing of gage of certain parts, and the addition of stiffening members. Usually such measures are successful, but invariably they result in a surprising increase in weight, and in many cases intensified localization of stresses, which in turn call for further reinforcements.

About the time the design has become thoroughly stabilized structurally, it becomes painfully evident that it is either insufficiently powered for the increased weight, that it is too heavy in proportion to its capacity, or both. Often an increase in power can be provided without too much redesigning—a larger bore in the same basic engine, a little bigger clutch, some stiffening of the gearbox and axle carrier, and a shift here and there in bearings or gear width—but with the structure "heavied-up" by essential reinforcements, there is little hope for a decrease in weight if the required stamina is to be retained.

By this time the progressive builder will have more advanced models well along in development, embodying improvements in design, materials and the technique of fabrication, which result in substantial gains in performance ability and savings in weight. Thus a new coach model is born.

In the remainder of their paper the authors detailed some of the coach body developments referred to in the foregoing, with the aid of numerous illustrations based on the latest Mack practice.

The Armored Force

THE DEVELOPMENT and the employment of the Armored Force was explained by Major General Charles L. Scott, who said there had been considerable confusion as to the difference between the motorized unit and the mechanized or armored unit—and that there was a vast difference. The motorized unit, he said, is one which transports a part or maybe all of its supplies, its weapons and personnel to the battlefield in trucks. There the unit dismounts goes into action, and most of its vehicles are sent to the rear. In very few instances they are employed as weapons on the battlefield. On the other hand, an armored unit transports all of its personnel in armed and armored vehicles, most of which, such as tanks, are employed as weapons. This type of unit can fight mounted, dismounted, at a halt or in motion—usually by a combination of all these methods.

The Armored Force is particularly designed to execute all the mobile missions of the ground army—rapid strategical moves, deep envelopments, pursuit, exploitation of the break-through, etc. It works intimately and constantly with observation and combat aviation. The ratio of machine gun fire power in armored units to that of other arms is very great. For example, the Infantry streamlined division of eight or nine thousand men carries and operates about 250 caliber 0.30 machine guns; the armored division of 11,000 men carries 4,000 caliber 0.30 machine guns—about 14 times as many as the Infantry division!

The speaker said he did not intend to convey the impression that the Armored Division was more useful and more powerful in all instances than the Infantry division, because it was not. The armored division is sensitive to terrain, cannot work in mountainous country and marshes, and is slowed down in terrain cut up by numerous stream lines. It is a powerful striking force but is weak in manpower for

(*Turn to page* 95, *please*)

Army and Navy Speakers Highlight SAE Meeting

Top Ranking Officials Stress Quality, Say 250,000 Vehicles Are Only Small Part of Defense Requirements

Based largely on National Defense activity, the program of the Annual Meeting of the Society of Automotive Engineers held in Detroit, Jan. 6 to 10, drew one of the largest gatherings of members, students, and guests in the history of this annual event. A number of the sessions were graced by the presence of top ranking members of the Army and Navy who, by the character of their papers and by their professional attainment, instilled utmost confidence in those who attended.

The military character of the convention was further emphasized by an imposing display of motorized military equipment, supplied by the Quartermaster Corps and the Ordnance Department.

Maj.-Gen. E. B. Gregory, quartermaster-general of the U. S. Army, told the annual meeting of the Society of Automotive Engineers at Detroit that the army now has 60,000 motor vehicles in service but this number will be more than tripled in the next six months. Present plans call for 100,000 vehicles by March and 190,000 by July 1. This will represent more than 17 times the number in service four years ago and compares with 3437 on hand in April, 1917, just prior to the first World War. Sixty thousand vehicles will remain to be delivered in the late summer and fall, bringing the total Quartermaster Corps fleet to 250,000 units.

These 250,000 vehicles will be divided approximately as follows:

Motorcycles	27,000
Bantam ¼-ton tucks	4,500
Passenger cars	5,900
Ambulances	3,400
½-ton trucks, pickup & reconnaissance	69,000
1½-ton trucks	44,000
2½-ton trucks	58,000
4-ton trucks	3,800
6-ton and heavier trucks	3,800
2½-ton truck tractors with one trailer each	37,800

"It is our aim," said General Gregory, "to keep our motorization policy as definite as possible and, at the same time, to keep it flexible so that there will be room for experimentation with, and testing and adoption of, new ideas."

Maj.-Gen. Charles L. Scott, acting chief of the Armored Force, pointed out at another session that there is a vast difference between the motorized unit and the mechanized or armored unit.

"The motorized unit is one which transports a part or maybe all of its supplies, its weapons and personnel to the battlefield in trucks," said General Scott. "There the unit dismounts and goes into action, and most of its vehicles are sent to the rear. . . . On the other hand, an armored unit transports all of its personnel in armed and armored vehicles, most of which, such as tanks, are employed as weapons."

General Scott also mentioned the need for trained technicians by the Armored Force, which maintains a school with a capacity of 5000 students, who are trained to be skilled motor mechanics or radio operators.

In conclusion, he said, "I want to forcibly state that an army and navy

(*Turn to page* 91, *please*)

The Brass-Hat Rack

"Mr. Whiffle—I think one pencil sharpener is the bottleneck of our organization"

Buick, Studebaker Prepare For Aircraft Engine Output

Personnel Shifts and Building Projects Underway As All Industry Shoulders the Defense Burden

Preparing for the production of Pratt & Whitney 14-cylinder aircraft engines, Buick Motor Division of General Motors has shifted more than 40 men in its executive personnel in order to meet the demands of the new project. Buick has been approved for a Government project of $24,313,150 for the erection and equipping of the airplane engine plant. The tentative site is Grand Blanc, Mich., a small village six miles south of Flint.

Dale E. Williams, former controller, has been named operating manager of the Aircraft Division which will have its own production organization. J. G. Hammond, former general superintendent, will be manufacturing manager. R. H. Archer, former chief of standards, will be general superintendent of the Aircraft Division, assisted by James O'Neil, formerly of the gear and axle plant.

H. E. Hardenbrook will be works engineer and R. E. Mitchell will be master mechanic of the new organization. C. L. Foreman will be chief metallurgist and C. E. Wooliever will be personnel director. Harry C. Young will be controller. C. N. Ofield will be chief inspector of aircraft production.

To fill the vacancies in the Automobile Division, Walter N. Larke, former assistant, will become general superintendent, succeeding Mr. Hammond. B. H. Newell, foundry superintendent, takes over as assistant general superintendent with D. G. Mixer succeeding him as foundry superintendent. John F. Kennedy, former assistant, is the new chief of standards, while Albert R. Bender, former assistant, becomes chief inspector. Buick will be the second GM Division to produce aircraft engines, the Allison Division at Indianapolis already turning out liquid cooled engines for the army. Buick will produce 1200 hp. radial engines of 1830 cu. in. displacement.

Studebaker Corp. also has received a National Defense award of $36,799,300 to acquire aircraft engine manufacturing facilities at South Bend and Fort Wayne, Ind., and Chicago. Studebaker is to turn out the Wright Aeronautical "2600" engine.

Both projects will be carried out under the terms of the emergency plant expansion. The companies will furnish the funds but the government will repay the cost over a five-year period. At the end of five years the contractor has the option of purchasing the property at cost less depreciation or leaving the title with the government.

After visiting the plant of the Consolidated Aircraft Corp. at San Diego, Cal., Edsel Ford, president of The Ford Motor Co., said the facilities of the Ford Rouge Plant would be available for producing parts for the Consolidated B-24 Bomber.

"We will do it if we can, and we think we can," Ford said after conferring with Maj. Reuben H. Fleet, president of Consolidated. "Although we can use many of the tools already on hand in our plants for the machining of some parts," Ford continued, "it will be necessary to install special dies, jigs, and forms adapted to aircraft production. This tooling period will be a matter of months. Our company is readying itself as rapidly as possible and the flow of parts to the assembly plant can possibly start within a year."

The B-24 Bomber is one of the three types of bombers for which the National Defense Commission has asked the automotive industry to supply wing and fuselage parts. It is a four-engine craft weighing 21 tons gross. Ford also conferred with Donald Douglas of Douglas Aircraft Corp., Santa Monica, Cal.

Ford already is rushing for completion by Jan. 27 a $21,000,000 aircraft engine plant at River Rouge to fill a defense order for 4236 Pratt & Whitney 18-cylinder radial engines. The plant is scheduled for operation by March 29. Installations of an $800,000 magnesium foundry within the present foundry building at the Rouge plant also is underway. Nineteen furnaces with a combined capacity of 500,000 lb. per month will supply the aircraft engine plant with magnesium castings.

Another phase of the Ford defense activity was the arrival Jan. 11 of 240 naval recruits from the Great Lakes Naval Training Station for three months training as machinists, metalsmiths, electricians and pattern-makers in the Ford plant. Four naval barracks have been built on the River Rouge property and ultimately 1000 sailors will be accommodated.

Recent National Defense contracts to Michigan include $1,216,000 to the Bohn Aluminum & Brass Corp., Detroit, for plant expansion and manufacture of aircraft engine parts; $1,669,678 to the Ex-Cell-O Corp., Detroit, for airplane engine parts, and $1,239,000 to Kelsey Hayes Wheel Co. for projectiles. Kelsey Hayes will use approximately one-fourth of its Jackson plant for the Ordnance order.

Heavy snow storms and low temperatures, usually serious handicaps in structural steel operations, have failed to retard progress on the construction of the Tank Arsenal being built by the Chrysler Corp. at Detroit.

The Arsenal, the largest of its type in the world, will be 1380 ft. long and 500 ft. wide, and is expected to cost $20,000,000. Ground was broken Sept. 11 and to date almost half the steel work has been completed. The Stars and Stripes were raised on Jan. 9.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., will operate two government ordnance plants, one to be built at Louisville, Ky., the other at Canton, Ohio. James R. Weaver has been appointed manager of the Louisville plant and R. V. Gavert will be in charge of the Canton plant.

Goodyear Tire & Rubber Co., Akron, is reported to have received a $13,899,541 contract to equip and operate a new powder bagging plant on the Ohio River near Charlestown, Ind.

A $3,000,000 order for trailers for the United States Army has been received by Nash-Kelvinator Corp. The trailers will be manufactured at the Racine, Wis., plant of Nash Motors Division and will begin to come off production lines about March 1.

Manufacturers' Message

Detroit, Mich.,
Dec. 30, 1940

Mr. President
The White House
Washington, D. C.

The automotive industry accepts without qualification your declaration of the urgency of defense production. It is putting into the effort every facility that can be usefully employed, and will respond in full measure to every call for service that comes to it from our government's Office of Production Management, regardless of sacrifices that may be involved.

Alvan Macauley, President,
Automobile Manufacturers Association.

Illinois Tech Starts Defense Training

H. T. Heald, president of the Illinois Institute of Technology in Chicago, has announced that more than 1000 men have enrolled in a tuition-free engineering defense training curriculum to take short-term, highly-specialized courses designed for those now in engineering industries who have had their basic training. The courses began Jan. 6 and classes for an additional 200 will begin Feb. 1.

The objective of the courses is to provide educational training of a college level to meet a shortage of engineers with specialized training. Courses will run on a 15 to 20-week basis of two meetings weekly and include design of tools and testing equipment, tool and fixture design, testing and inspection methods, welding engineering, structural drafting, diesel engines, time and motion study and metallurgy.

Acme

Canada Speeds Production

Credited with an important part in the success of the British African campaign, Canadian factories like this one are said to be turning out 400 war vehicles a day for British and Canadian consumption. Photos show an armored assembly about to be placed on a four-wheel-drive chassis and a general view of modern engine assembly line.

Steel Production At 97.2% Of Capacity Sets New Record

Steel Buyers More Confident of Adequate Supply as Producers Cite Capacity Increases in 1940 and Plans for More in 1941

While most steel company sales executives see little abatement in the volume of new business, there are some who say that they notice from day to day an increase in the number of consumers who no longer are as perturbed about their steel supply as they were a few months ago. Consumers have become reconciled to the longer interval between specifications and shipment, and have adjusted their purchasing methods accordingly, thus lessening the strain.

In issuing its estimate of 97.2 per cent of ingot capacity for the week ended Jan. 11, the American Iron & Steel Institute points out that the figure is based on the industry's capacity at the end of 1939 and that based on present facilities the percentage would be lower because of steel plant expansion in 1940. An even more marked addition to capacity is expected in 1941, and operating rates this year must be interpreted with that impending change in mind. Steel output for the week ended Jan. 11, including electric furnace production and that of steel foundries, was estimated at more than 1,500,000 net tons, setting a new record.

Being vitally interested in the price of scrap, not only as the largest consumers of steel but also as the leading marketers of scrap, automobile manufacturers and parts makers are taking a deep interest in the inquiry begun this week by the Defense Advisory Commission into the price of scrap and the scrap market set-up. Because of the large number of scrap iron dealers and brokers, regulations and enforcement of such regulations to prevent hoarding and speculation present one of the most difficult problems that the Commission has had to deal with. It is feared by steel producers that, unless scrap prices can be frozen at somewhat below prevailing market prices, the program of keeping finished steel prices on an even keel will be seriously threatened.

New lists of extras on hot rolled carbon steel bars and strip steel, effective Jan. 6, have been issued by the leading interests, revision having become necessary to transfer some dimensions, that belong more logically within the bar classification, from the strip list.

Custom smelters and outside marketers of copper marked their asking price for electrolytic copper up to 12½ cents this week. Mine producers continue to quote 12 cents, but there appears to be a moderate volume of demand from consumers, who depend on the outside market for their supply.

W. C. H.

CALENDAR

Conventions and Meetings

National Automobile Dealers Association, Convention, Pittsburgh, Pa., Jan. 22-23

Automotive Tool & Die Manufacturers Association, Detroit .....Jan. 21

Inventor's Convention, New York, N. Y., Jan. 23-30

American Road Builders Association, New York .....Jan. 27-31

American Institute of Electrical Engineers, Winter Convention, Philadelphia .....Jan. 27-31

Automotive Parts & Equipment Manufacturers, Annual Meeting, Detroit, Jan. 28

American Management Association, Annual Personnel Conference, Chicago, Feb. 12-14

Chamber of Commerce of the U.S.A., Washington, D. C. .....Apr. 29-May 1

Shows

National Motor Boat Show, New York, Jan. 10-18

Chicago Motor Salon, Chicago.....Feb. 1-9

Southwest Automotive Show, Fort Worth, Tex. .....Feb. 6-9

Machine & Tool Progress Exhibition, Detroit .....Mar. 24-29

Motor Boat Show Now in Progress

One-hundred-thirty boats ranging in price from $25 to just under $38,000 are on display at Grand Central Palace, New York, where the 36th annual National Motor Boat Show is under way. Opened on Jan. 10, the show will continue until Saturday, Jan. 18.

Highlights of the marine engine displays, which reveal a continued trend toward fuel oil power for a wide range of boat sizes, will be described in the Feb. 1 issue of Automotive Industries. New models by both Diesel and gasoline engine builders were in evidence as well as noticeable changes in outboard and small air-cooled inboard designs.

Arthur C. Houser

Arthur C. Houser, manager of the Washington, D. C., offices of the Cleveland Diesel Engine division of General Motors Corp., died Dec. 18.

GM, Ford Figure in New Labor Activities

Dr. Taylor Named Permanent General Motors Labor Umpire as Union Signs New Contracts on Wide Front

Dr. George W. Taylor, associate professor of industry at the University of Pennsylvania, was appointed Jan. 8 as the new permanent umpire between General Motors Corp. and the UAW-CIO. He succeeds Dr. Harry A. Millis, who served little more than a month before he resigned in November to become chairman of the NLRB.

Dr. Taylor, who is 39 years old, is nationally prominent as a labor mediator. He has served as chairman for the Full-Fashioned Hosiery Institute for 11 years, the Philadelphia Men's Clothing Industry for eight years and the shirt industry of Philadelphia for five years. He has been chairman of the Philadelphia Regional Labor Board since 1934. He will make his headquarters in Detroit.

Meanwhile, employes of the Detroit forge, gear and bumper plant of the Chevrolet Motor Division sent a notice of intention to strike to the Michigan State Labor Board after voting for a strike, 1533 to 212. Officials of the UAW-CIO charged that the wages of hammermen and other employes had been reduced as much as 50 per cent due to improper job rating. The impartial umpire does not have jurisdiction over wage disputes under the GM contract. James F. Dewey, Federal conciliator, entered the case Jan. 8 and conferred with union and GM officials.

Dewey also conferred with Ford Motor Co. officials, including Harry H. Bennett, personnel director, over the layoff of 300 workers at the Ford Rouge and Lincoln plants. Officials of the UAW-CIO charged that the layoffs were for union activity, while Bennett maintained they were the usual seasonal year-end layoffs. The union also protested the transfer of production of Mercury convertible models from the Lincoln to the Rouge plants, asserting this would make 400 men idle. Bennett countered that the men had been transferred to the Rouge plant, too, and would be put back to work as needed.

Marking a precedent in Ford labor relations at Detroit, Bennett first met Dewey in a conference Jan. 3, at which Bennett agreed to put back to work any employe who Dewey found had been discriminated against for union membership. Bennett refused a union proposal to arbitrate the question of transferring the Mercury body work to the Rouge plant, contending that this was a matter of company policy not open to arbitration or discussion.

Earlier, on Dec. 31, the UAW-CIO petitioned the Detroit office of the NLRB for an employe election at the Lincoln plant, which employs 3800 men. Members of Ford Local 600 in the Lincoln plant voted, Dec. 20, to call a strike there if necessary and the UAW-CIO maintained that 95 per cent of the Lincoln workers are union members. Dewey entered the case when Michael F. Widman, Jr., director of the Ford organizing drive for the UAW-CIO, telegraphed Dr. John F. Steelman, of the Dept. of Labor, asked for Federal intervention "in the interests of national defense."

The Ford Motor Co. filed an appeal, Dec. 31, with the U. S. Supreme Court from the decision handed down last Oct. 6 by the Sixth Federal Circuit Court in Cincinnati which had found the company guilty of unfair labor practices and had granted enforcement of an NLRB order to reinstate 23 discharged employes and to cease interfering with collective bargaining rights. The Ford petition said the lower court should not have held it an unfair labor practice "to discharge men who were members of an organization (the UAW-CIO) which the company had reason to apprehend would attempt to seize the plant by force and violence."

An unauthorized cessation of work, Jan. 3, at the Briggs Mfg. Co., when 120 workers walked out of the metals department on the night shift after a dispute over decreasing manpower, brought a letter of censure from officials of the UAW-CIO. Thomas said that any further unauthorized stoppages of work in violation of the contract signed with Briggs, Dec. 13, would result in penalties to those concerned and that such incidences only served to weaken the union.

New contracts with five automotive plants brought raises estimated at more than $1,500,000 to members of the UAW-CIO. Following 10 days of negotiations, a contract with the Packard Motor Car Co. was signed, Dec. 30, calling for a blanket increase of 3 cents per hour to hourly rated workers in lieu of vacation pay. This will mean $800,000 more in wages per year for 13,000 Packard workers and $700,000 in increased wages to the 12,000 men who are expected to be employed in the new airplane engine plant.

A contract between the Budd Wheel Co. and the UAW-CIO was approved Jan. 5. This calls for $400,000 in increased wages and bonuses for 6000 employes. There will be a general wage increase of 3 to 8 cents per hour and a 2 per cent bonus based on total earnings during 1940 to be paid in May. A minimum hourly rate of 75 cents for women and 78 cents for men was set.

Clean Cotton

John Rust, co-inventor of the mechancial cotton picker, shown at the wheel of his new mechanical cotton cleaner which removes the trash and turns out a product said to be equal to hand-picked cotton.

Curtis Tomahawks for R. A. F.

Curtis Hawk 81A Pursuits for Great Britain are rolling off the huge assembly line in the Buffalo plant of Curtis-Wright Corp. at the rate of eight planes a day. Dubbed "Tomahawks" by the British, they are export versions of the Curtis P-40 Pursuit and supplement the factory's output for American Defense.

S.A.E. Meeting

(*Continued from page* 87)

alone, no matter how large . . . are not sufficient for national defense. They must be backed up by well organized and efficient industries and supported by public opinion."

In the absence of Maj.-Gen. George H. Brett, chief of the Army Air Corps, who was unable to attend due to illness, his paper was read by Brig.-Gen. Oliver P. Echols, chief of the Air Corps material division.

General Brett's paper emphasized the fact that quality should be maintained in aircraft production and he quoted an American observer in England who asserted that the success of the RAF was due to the refusal of the British to surrender to the pressure for cheaper and more easily produced airplanes.

He concluded, "Let nothing swerve you from the American policy of highest quality in the greatest abundance of which your best efforts are capable."

Rear-Admiral John H. Towers, chief of the U. S. Navy Bureau of Aeronautics, pointed out a way for the automotive industry to help in the Navy's vast shipbuilding program when he stated that a man o'war contains everything to the kitchen stove, and that manufacturers could help out by supplying some of the many items that go into a Navy vessel.

Even the engineering display, featuring many familiar names of automotive suppliers such as Bakelite, Stewart-Warner, Aluminum Co. of America, Monroe Equipment Co., Continental, Hercules, Waukesha, Ex-Cell-O, and others, showed exhibits of recent military developments. Ross Gear & Tool Co., for example, showed a special double-arm steering gear designed for the simultaneous steering of front and rear wheels. This arrangement is intended for the small Bantam four-wheel drive cars and is available in two different forms of gear boxes.

Gemmer had an interesting display featuring its new heavy-duty steering gear designed to ease the burden of steering on trucks and buses. Another development was the announcement of a new method of chrome plating piston rings by the American Hammered Piston Ring Division of Koppers Co.

At the annual banquet presided over by L. Clayton Hill, vice president of the Murray Corp. of America, as toastmaster, Sir Louis Beale, of the British Purchasing Commission, was the principal speaker. A. T. Colwell, vice president of Thompson Products, Inc., Cleveland, and the new president of the SAE, also was a speaker.

Other new officers of the society for 1941 are: vice-presidents—Mac Short, vice-president of Vega Airplane Co., representing aircraft engineering; G. W. Lewis, director of aeronautical research, National Advisory Committee for Aeronautics, representing aircraft engine engineering; L. C. Lichty, associate professor of mechanical engineering, Yale University, representing diesel engine engineering; J. B. Macauley, Jr., Chrysler Corp., representing fuels and lubricants; K. M. Wise, Bendix Products Div. of Bendix Aviation Corp., representing passenger car engineering; J. R. Hughes, chief body engineer, Studebaker Corp., representing passenger car body engineering; E. S. Chapman, vice-president, Plymouth Div. of Chrysler Corp., representing production engineering; Chauncey W. Smith, professor of agricultural engineering, University of Nebraska, representing tractor and industrial engineering; T. L. Preble, Tide Water Associated Oil Co., representing transportation and maintenance engineering, and R. S. Reed, chief engineer, Brockway Motor Co., Inc., representing truck, bus and railcar engineering. David Beecroft, Bendix Prod. Div. of Bendix Aviation Corp., was elected treasurer.

Preliminary Statistics of the Automobile Industry for the Calendar Year 1940

As estimated by the Automobile Manufacturers Association

PRODUCTION AND VALUE

Car and truck factory sales, U. S. plants	4,476,000
Passenger cars	3,705,000
Motor Trucks	771,000
Percentage increase over 1939. Motor vehicles	25%
Wholesale value of cars	$2,413,800,000
Wholesale value of trucks	$598,300,000
Wholesale value of cars and trucks	$3,012,100,000
Wholesale value of parts, accessories and tires for replacement, and service equipment	$1,250,000,000
Motor vehicles, accessories, service equipment and replacement of parts and tires	$4,262,100,000

REGISTRATION

Motor vehicles registered in U. S.	31,950,000
Passenger cars	27,300,000
Motor trucks	4,650,000
Per cent of new vehicles sold in U. S. required for replacement of vehicles scrapped (average 1930-40)	84%
World registrations of motor vehicles	47,000,000
Per cent of World's automobiles in U. S.	69%
Per cent of motor vehicles on farms and in villages under 2500 population	41%

TAXES

Total motor vehicle user taxes	$1,772,000,000
Gasoline taxes, Federal, state and municipal	$1,120,000,000
Percentage motor vehicle user taxes to all taxes	11%

EMPLOYMENT

Employment in automobile, body and parts factories	443,000
Weekly payroll, wages	$15,400,000

MOTOR TRUCKS AND BUSES

Motor trucks in use	4,650,000
Total special motor truck taxes	$460,000,000
Taxes per dollar of gross revenue, for-hire trucks	6.8¢
Number of bus and truck drivers	3,900,000
Motor buses in use	144,000
Number of communities served only by motor vehicles	48,000

NATIONAL DEFENSE

Total contracts for defense equipment to date undertaken by Motor Industry (including aircraft)	$1,076,082,000

FOREIGN SALES

Number of motor vehicles exported from U. S.	230,000
Per cent of U. S. Production exported	5.1%
Value of motor vehicles, parts and tires exported	$280,000,000

MOTOR VEHICLE RETAIL BUSINESS

Total car and truck dealers	41,494
Total repair shops	87,366
Total retail outlets (duplicates eliminated)	94,985
Wholesalers	6,264
Retail gasoline outlets	400,000

Business in Brief

***Written by the Guaranty Trust Co., New York, Exclusively for* AUTOMOTIVE INDUSTRIES**

Business activity is maintained at a high level, although a pronounced seasonal drop was registered in the final week of December. The unadjusted index of *The Journal of Commerce* for the week ended Dec. 28 stands at a preliminary figure of 97.3 per cent of the 1927-29 average, as against 115.0 for the preceding week and 91.5 a year ago. The New York *Times* adjusted index for the same period stands at 114.2 per cent of the estimated normal, as compared with 115.6 a week earlier and 106.8 for the corresponding period in 1939.

Department store sales during that week, according to the Federal Reserve report, were 59 per cent larger than a year ago. The exceptionally large increase is attributed mainly to the fact that the week contained two Christmas shopping days, whereas the similar week of last year did not. Retail trade declined much less than seasonally during the week ended Jan. 4, according to Dun & Bradstreet.

Railway freight loadings declined less than seasonally during the week ended Dec. 28, totaling 545,307 cars, 21.8 per cent below the figure for the preceding week and 0.5 per cent below that a year ago.

After establishing a new all-time record during the week ended Dec. 21, electric power production declined seasonally in the following week, being 9.9 per cent smaller than in the preholiday period but 9.1 per cent larger than in the similar period of 1939.

Bank debits to deposit accounts in leading cities during the week ended Dec. 25 were nine per cent greater than in the comparable period of 1939. The total for the thirteen weeks ended on that date was eight per cent above the corresponding total a year earlier.

Commercial and industrial failures in the week ended Dec. 26 numbered 190, according to Dun & Bradstreet, as against 255 a week earlier and 190 in the comparable 1939 period. The total for the year up to that date was 7.3 per cent below that a year ago.

Engineering construction contracts awarded last month reached the second highest total on record, according to *The Engineering News-Record*, being exceeded only by the October figure. The total for the year was a new all-time high, exceeding even the previous peak in 1929.

Bituminous coal production for the week ended Dec. 21 averaged 1,650,000 tons daily, as against 1,653,000 tons in the preceding week and 1,546,000 tons in the similar period a year ago.

Crude oil production during the week ended Dec. 28 averaged 3,385,500 barrels daily, 235,700 barrels below the figure for the preceding week and considerably below estimated requirements of 3,560,000 barrels.

Professor Fisher's index of wholesale commodity prices for the same period stands at 85.2 per cent of the 1926 average, as against 84.9 a week and two weeks earlier and 85.0 three weeks earlier.

Member bank reserves rose $189,000,000 during the week ended Dec. 31, with a gain of $65,000,000 in the gold stock and declines of $84,000,000 in money in circulation and $113,000,000 in Treasury deposits with the Federal Reserve banks more than offsetting a decline of $62,000,000 in Reserve bank credit.

Tool Builders Pledge Faster Defense Output

Makers Outline 4-Point Plan to Raise Machine Tool Production to $650,000,000 in 1941

Subcontracting more work, employing and training more men, further plant expansion and maximum use of existing facilities constitute a four-point defense program adopted by the National Machine Tool Builders Association for further speeding up of machine tool output to an extent beyond increases already announced for 1941. The association took this action at a meeting in Washington on Jan. 6 and 7. William S. Knudsen, Director General of the National Defense Commission's Office of Production Management, again urged greater speed in production.

F. V. Geier, President of the association, said that members of the industry have pledged themselves to increase production beyond the previous promise to Mr. Knudsen and look to the following methods for accomplishing the result:

"(1) Subcontracting more work to outside concerns. This will bring still more of the country's facilities into prompt production for more machine tools.

"(2) Employing and training more men. The industry has proved its ability to train new men extensively, and will expand this program.

"(3) Further plant expansion as indicated by specific needs.

"(4) Maximum utilization of plants and equipment."

Mr. Geier pointed out that December production passed all previous monthly records and that totals would continue to mount month by month throughout 1941. He said that on Dec. 27, the industry sent a letter to Mr. Knudsen, advising him that it could be expected to turn out machine tools to the value of $650,000,000 in 1941. At the meeting, he added, members were called upon to speed up deliveries even further.

"Our industry is fully aware of the difficulties of determining defense requirements for machine tools," said Mr. Geier. "We have considered it our duty in the past to point out that the Nation's defense job cannot be done effectively unless we are given definite information as to requirements, so that we shall know what is needed, when it is needed, and where it is needed, in the order of critical importance.

"The members of the industry are very glad indeed to learn that definite plans are now under way on the part of the National Defense Commission to meet our request. We have been assured that every effort will be made to define more accurately the actual machine tool requirements for national defense, and we can promise positive assurance that such definition will be reflected in specific, immediate programs of accomplishment."

Gisholt to Increase Further Production

Gisholt Machine Co., Madison, Wis., has just announced the reopening of its Northern Works, also located in Madison, in order to meet the current demands of the defense program for turret lathes.

This expansion, for production of Gisholt turret lathes, adds 60,000 sq. ft. to the present manufacturing facilities. It is planned that operations will start in this plant by May 1 and production will be fully under way by the middle of the year. Work has already started on reconditioning the building, last used in 1930.

Truck Production by Capacities

(U. S. and Canada)

	ELEVEN MONTHS				
	Units			Per Cent of Total	
	1940	1939	Per Cent Change	1940	1939
1½ Tons and less	699,959	616,913	+ 13.3	88.48	91.63
2 to 3 Tons	55,463	32,187	+ 72.2	7.01	4.78
3½ Tons and over	14,513	12,399	+ 17.0	1.83	1.84
Special and buses	7,489	5,537	+ 35.1	.95	.82
Station Wagons	13,713	6,257	+119.5	1.73	.93
Total	791,137	673,293	+ 17.8	100.00	100.00

Vascoloy-Ramet Improves Carbide Tool Service

The sales engineering forces as well as much of the manufacturing resources of Vascoloy Ramet Corp., Fansteel Metallurgical Corp., and Vanadium Alloy Steel Co., have been pooled in order facilitate prompt distribution of Vascoloy-Ramet tantalum-tungsten and other cemented carbine tools. The announcement came in the form of a joint letter mailed to customers by each of the three companies.

Heretofore Vascoloy-Ramet tools and blanks have been sold and serviced through various district offices of Vanadium-Alloys Steel Co. and a number of authorized agents. This service is now being extended as a direct sales engineering force under the management of Vascoloy-Ramet Corp., factory owned branches have been established at Detroit, Cleveland, Cincinnati, Pittsburgh, Providence, Hartford, Jersey City, Philadelphia and Milwaukee.

New Standard For Gage Blanks

It is announced by the Division of Trade Standards, U. S. Department of Commerce, that a revised standard for gage blanks, identified as CS8-41, is effective for new production as of Jan. 1, 1941, and will become effective for clearance of existing stocks on Jan. 1, 1942. The revised version was circulated for written acceptance on Oct. 22. Signed acceptances were received from a number of manufacturers, distributors and users, and since there was no active opposition, it was adopted. Printed copies of the new standard CS8-41 can be had from the National Bureau of Standards, Washington, D. C.

40 YEARS AGO

The following curious reply was sent by an advertiser who made use of our special notice column. The writer evidently knows something about the joys and the troubles of the chauffeur as well as about his business tricks:

"I noticed your ad in the HORSELESS AGE of a second-hand gasoline rig, to sell at a bargain. I have figured that by buying a second-hand machine my experience would cost me less than the other fellows. If you paid $750 for your machine and now want $350 you must have a good reason for selling.

"Please give me your reasons. Going to move to sandy and mountainous country? Pressure of business? Ill health? Need of ready cash? Having a larger machine built? Going to Europe? Or what? But give me facts and if I buy and then decide to sell, I will not infringe on your ideas when I come to state my reasons for selling.

"Please state catalog power of engine and then actual power, as you found it. If the machine does not do the work, is it so built that engines and tanks can be taken off and shafts attached? Your prompt reply, etc."

From the *Horseless Age*, January, 1901.

Dynamometers Check Bearings

Keeping pace with rapid strides in engine bearing developments, Federal-Mogul Corp. has added this dynamometer laboratory. Two hydraulic-brake engine dynamometers are shown at left while a chassis dynamometer is in the background.

MEMA November Index Well Above 1939 Level

While November shipments in all divisions of the industry excepting service equipment declined seasonally below the previous month, all continue well above the November, 1939, level, according to the Motor & Equipment Manufacturers Association. The grand index for all branches of the industry stood at 183 per cent of the January 1925 base as compared with 190 in October, and 135 in November a year ago.

William F. Glickert

William F. Glickert of Indianapolis and former superintendent of the Stutz Motor Corp., died Jan. 2.

AMA Considers Dropping of N. Y. Show

Members of the Automobile Manufacturers Association have under consideration a proposal to call off the National Automobile Show in New York next fall. Nothing definite will be done about it, according to the A.M.A., until meeting of the board of directors, which is scheduled tentatively some time in the next two weeks.

ADVERTISING

Brooke, Smith French & Dorrance, Inc., Detroit advertising agency now handles the account of the American Brakeblok Division of American Brake Shoe & Foundry Co., Detroit.

Burns & Potter, Chicago, is directing the advertising of Buell Mfg. Co., also of Chicago.

W. D. Murphy, formerly advertising manager of Sloan Valve Co., Chicago, is now an executive in the agency of Reincke-Ellis-Youngreen & Finn, Chicago.

Ellis J. Travers, manager of the Detroit office of Ruthrauff & Ryan, Inc., has been transferred to the agency's New York office.

Estimated Dealer Stocks of New Passenger Cars

1939	July	August	September	October	November	December
Production—U. S. Domestic Market †	142,346	56,245	155,430	239,150	272,747	357,712
Retail Sales—U. S. ‡	229,873	166,172	139,222	236,584	257,398	274,233
Change in Inventory	−87,527	−109,927	+16,208	+2,566	+15,349	+83,479
Inventory, First of Month	295,708	208,181	98,254	114,462	117,028	132,377
1940	**January**	**February**	**March**	**April**	**May**	**June**
Production—U. S. Domestic Market †	348,755	324,555	341,634	351,814	315,441	276,949
Retail Sales—U. S. ‡	239,509	236,857	338,153	353,423	330,521	350,871
Change in Inventory	+109,246	+87,698	+3,481	−1,609	−15,030	−73,922
Inventory, First of Month	215,856	325,102	412,800	416,281	414,672	398,592
1940 (continued)	**July**	**August**	**September**	**October**	**November**	**December**
Production—U. S. Domestic Market †	165,672	45,172	220,696	411,016	395,860	.....
Retail Sales—U. S. ‡	298,683	177,679	158,083	326,097	334,520	.....
Change in Inventory	−133,011	−132,507	+62,613	+84,919	+61,340	.....
Inventory, First of Month	324,670	191,659	59,152	121,765	206,684	268,024

†—U. S. Census Bureau. ‡—Automobile Manufacturers Association.

MEN . . . . . .

Charles E. Wilson, acting president of General Motors Corp., since William S. Knudsen retired to join the Defense program, has been elected president of the corporation.

Dr. Edward E. Minor, Jr., research and development engineer of the Glenn L. Martin Co., Baltimore, Md., has been appointed chairman of the Air Transport Committee of the American Institute of Electrical Engineers.

William Porter Witherow, Pittsburgh steel manufacturer and president of Blaw-Knox Co., has been appointed chairman of the National Defense and Industrial Mobilization Committee of the National Association of Manufacturers.

Harry L. Erlicher, purchasing agent of General Electric Co., Schenectady, N. Y., since 1931, has been elected a vice-president of the company.

L. C. Allenbrand has been made general manager of the sales development division of Caterpillar Tractor Co., Peoria, Ill., succeeding **G. E. Spain,** recently promoted to general sales manager. **H. B. McKinley,** assistant treasurer of the company has retired.

Paul B. Hoffman, formerly advertising manager of American Brakeblok Division of American Brake Shoe & Foundry Co., Detroit, has been named general sales manager.

O. C. Holaday is the new general sales manager of Ramsey Accessories Mfg. Corp., St. Louis.

Bunting Brass & Bronze Co., Toledo announces the following appointments in its sales engineering staff: **William T. Streicher,** Chicago; **John J. Mengler,** Kansas City; **Robert J. Bergum,** Minneapolis; **William Dorsey,** Seattle; **James F. Roberts,** Indianapolis, and **William A. Schneider,** Dallas.

David A. Cowhig succeeds George L. Briggs, resigned, as general manager of the Wilkening Mfg. Co., Philadelphia.

George A. Bryant, formerly executive vice-president and general manager of the Austin Co., Cleveland, has been named president and general manager succeeding the late W. J. Austin.

Robert E. McGill, since 1927 West Coast manager of the Automotive Replacement Parts Division of Aluminum Industries, Inc., Cincinnati, has been appointed sales manager, with headquarters in Cincinnati.

Robert G. Glass has been made assistant manager of operations by Carnegie-Illinois Steel for the Chicago district.

Mr. Henry M. Hale, Eastern sales manager of Caterpillar Tractor Co., Peoria, Ill., has resigned to enter into partnership with John R. Taylor as the Taylor-Hale Machinery Co. of Memphis. The new company will handle sales and service of "Caterpillar" products in an extensive southern area. **George Rinck,** formerly assistant Eastern sales manager, succeeds Mr. Hale with Caterpillar.

G. H. Ford, for many years chief timer at the Indianapolis Motor Speedway, heads a newly-created Test and Proving Division of the Marmon-Herrington Co., Indianapolis.

J. E. Lautsbaugh has been appointed director of purchases for The Crosley Corp., Cincinnati. He occupied a similar position with Westinghouse for the past 22 years.

L. L. Smith, has been elected treasurer of the B. F. Goodrich Co., Akron.

N. C. Raymond has been named president of A. S. Campbell Co., Inc., East Boston, Mass., succeeding A. S. Campbell, now chairman of the board.

Ralph H. Norton has been named chairman of the board of Acme Steel Co., Chicago succeeding **James E. MacMurray,** founder of the company and now retired after 50 years of service. **Charles S. Traer** succeeds Mr. Norton as president. **Frederick C. Gifford,** first vice-president and director of sales has retired. **Chester M. MacChesney** becomes first vice-president and secretary and **Carl J. Sharp** succeeds Mr. Gifford as director of sales.

B. A. Brown has been named assistant sales promotion manager of the Studebaker Corp., South Bend, Ind.

Fred R. Davis

Fred R. Davis, advertising space buyer for the General Electric Co. at Schenectady, N. Y., for 35 years, died Dec. 26. A man of scientific training himself, he was a pioneer advocate of accurate measurement in advertising. To further that end, he helped found the Audit Bureau of Circulation in 1914.

Macy Teetor Again In Composer Role

A few years back a hit song filled the airways. Its title was "Lost" and its composer was Macy O. Teetor, chairman of the engineering committee, Perfect Circle Co., Hagerstown, Ind. Now there is a new song hit from the same pen entitled, "I saw you first." Keep an ear peeled for this latest creation from the musical hobby of a leading engineer.

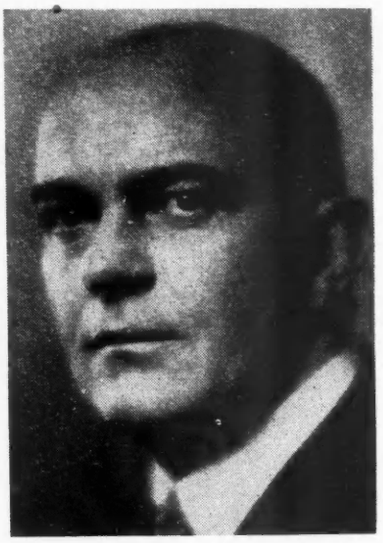
Globe

Flying Fortress Factory

Six months ago, Boeing Aircraft Co.'s Plant No. 2 at Seattle was the size of the small area at left. The new building brings floor area up to 832,000 sq. ft. (compared with an original 166,000 sq. ft.) and when the new plans are finished the total will be 1,900,000 sq. ft.

C. Harold Wills Dies

C. Harold Wills, chief metallurgist of Chrysler Corp., and one of the pioneers of the automotive industry, died Dec. 30. When Henry Ford was experimenting with his first automobile Mr. Wills worked for him as a draftsman.



C. Harold Wills

In 1903, Mr. Wills joined the Ford Motor Co. and remained with it until 1919 as chief engineer and manufacturing engineer.

In 1920 Wills founded the Wills-Ste. Claire Motor Car Co. at Marysville, Mich., which manufactured cars until 1927. In 1929 he developed a front-wheel-drive automobile known as the Ruxton and in 1933 he joined the Chrysler Corp., where among other achievements he is credited with the development of Amola steel.

PUBLICATIONS

A folder describing **Ruggedwear Resurfacer** has been issued by the Flexrock Co. Ruggedwear Resurfacer is especially designed to help those industries who are rushed and must make plant repairs either at odd hours or over the week-end so that no time is lost in production.*

Black & Decker Mfg. Co. has issued a new 60-page catalog fully illustrating its complete line of 132 **Portable Electric Tools.***

American Steel Foundries has a new folder illustrating and describing its **Fifth Wheel.** Three types are described and illustrated, the **30-in. Tilting Type; the 36-in. Rigid Type** and the **30-in. Side Oscillating Type.***

The Brown Instrument Co. has just published a new catalog, 15-E, **Brown Pyrometers-Millivoltmeter Type.** The catalog is well illustrated with photographs of indicating, recording and control millivoltmeter pyrometers. Constructional features and operating advantages are fully described.*

Standard Gage Co. has a new bulletin on its improved **Dial Bore Gages.** The title of the bulletin is "New Speed with Accuracy in Bore Checking" and describes three

*Obtainable through editorial department, AUTOMOTIVE INDUSTRIES. Address Chestnut and 56th Sts., Philadelphia. Please give date of issue in which literature was listed.

types of gages. The Standard Type, Pistol-Grip Type and the Vertical Type. The folder also contains specifications for these three gages and price lists.*

Catalog 840, **Seal Master Ball Bearing Units,** has been issued by Stephens-Adamson Mfg. Co. The catalog gives general information regarding Seal Master Ball Bearings, Specific information regarding each type of Seal Master Ball Bearing Units, engineering data, load rating tables and dimension tables for its complete line of bearings.*

Verson Allsteel Press Co. has issued Bulletin MBP40 describing "T" Series **Major Press Brakes.***

An attractive booklet on **Mayari R,** Bethlehem's high-strength corrosion-resisting steel has just been issued by Bethlehem Steel Co. The booklet contains many interesting features including, in addition to the description of Mayari R's various uses, tables giving the physical properties, chemical composition, etc.*

Allegheny Ludlum Steel Corp. has issued a **Handbook of Special Steels, Their Properties, Uses, Fabricators.** The handbook is designed to be as helpful as possible in the selection of the proper types of tools, stainless and electrical carbon steels in the various forms produced by Allegheny Ludlum. Tables have been used to facilitate quick reference.*

A new 8-page illustrated bulletin telling how to apply **CSP power transformers,** which are completely self-protecting, completely self-contained sub-stations for single feeder service on municipal or industrial distribution systems, is announced by the Westinghouse Elec. & Mfg. Co.*

How To Speed Up Production With Variable Speed Control, is the title of a booklet issued by the Reeves Pulley Co. The booklet is number G-412 and contains 36 specific examples in all types of industrial plants in which speed control has made possible definite production increases and advantages.*

The January issue of Nickel Cast Iron News, published by the International Nickel Company, contains, among other interesting items, a well-illustrated story on **nickel alloy cast irons** in Power Plant Equipment.*

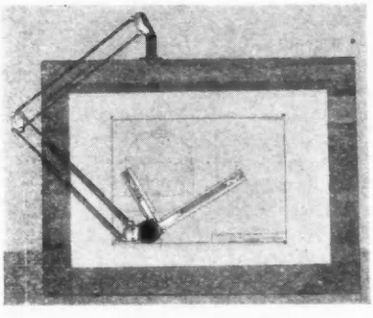
MEN and MACHINES

(*Continued from page* 73)

A New Drafting Machine

A new, low-priced drafting machine, designated as the "Master-Drafto" Model No. 60, which takes a maximum size sheet 24 x 36 inches, is announced by The Drafto Co. of Cochranton, Pa.

Lightness, easy operation and durability are claimed for this new device. The arms are constructed of seamless steel tubing, fitted with solid bearings. The scale blades are designed so that either a boxwood or aluminum scale can be inserted. For center mounting the machine on a drafting board or table, a cast aluminum bracket is used, containing a screw for leveling the scales parallel to the drafting surface.



"Master-Drafto" Model 60

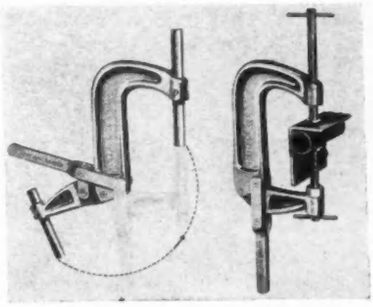
The stainless steel protractor plate is graduated in 2 degrees, and can be set for ½ degree readings by use of the graduated vernier. The graduations are machine cut, and are said to be easily readable. The protractor can be locked at any degree, but for speed and convenience, it is fitted with a latching spring to lock the scales at 0, 30, 45, 60 and 90 degrees on either side of the 0 degree reading.

New "C" Clamp with Quick Acting Toggle Movement

A new, portable clamp which the manufacturers believe combines all the advantages of the old "C" clamp with swift toggle action, is being produced by Detroit Stamping Company of Detroit, Mich. The new clamp has two holding rods instead of one, and when released by toggle action, the entire lower half swings clear of the work. The operator is thus enabled to get around obstructions in fixtures, and to take in and clamp firmly such pieces as angle iron or T-shaped iron, which were formerly difficult, if not impossible, to handle.

The two-rod adjustment permits of holding the work at exactly the right spot; and after once set, the adjustment need not be varied until the particular job in hand is finished.

The new clamp is made in two models. One has two threaded rods which permit quick, easy adjustment. The other has two smooth rods which are locked in adjustment by set screws. The latter is especially suited to arc welding work.



Detroit Stamping Co. "C" Clamp

The new clamp frame is of malleable iron, the rods of steel, and the toggle handles of case-hardened steel.

Annual SAE Meeting

(*Continued from page* 86)

holding missions. It must be employed skillfully and forcefully at the appropriate time and place, and be followed up promptly by other arms, in order to attain the greatest success in extensive operations.

Requirements of Smoke Meters

A PAPER on Requirements of a Smoke Meter (for use in evaluating the density of the smoke in the exhaust from Diesel engines) was read by Kenneth M. Brown of Caterpillar Tractor Co. He said such a meter should be sufficiently sensitive throughout the range of smoke densities to be measured, should be easy and simple to operate, and should be quite portable; that the light intensity should be capable of easy and smooth adjustment and should remain constant for any setting, and that the windows should not become dirty too quickly and should be easy to clean when dirty. These requirements, he said, are met fairly satisfactorily by a smoke meter developed in the Caterpillar laboratories. It is similar in principle to other instruments developed for the same purpose, comprising a main measuring tube 36 in. long, with inlet and outlet for the exhaust gas 3¾ in. from the ends, leaving dead-air spaces of that length, which tend to reduce smudging of the windows. There is a source of light at one end of the tube and a photo-electric cell at the other. The smoke in the tube reduces the intensity of the light thrown onto the photo-electric cell, thereby decreasing its output, which is indicated by a micro-ampere meter.

A new unit for smoke density was also proposed in the paper, viz., "smoke density per unit length of smoke column."

Toll Roads for Buses and Trucks

THE CONSTRUCTION of a system of super highways between the large centers of population in the East and the Middle West, which would be operated on a toll basis, was advocated by Charles M. Noble, special highway engineer for the Pennsylvania Turnpike Commission. He said the truck and bus industries might not be aware of the interest of such roads to them at present, but he predicted that consciousness of the toll road and its effect on transportation would quicken in the near future. He explained that the type referred to was express highways completely grade-separated, on a controlled right of way with no frontage permitted, access restricted to definitely prescribed points, a minimum of two full lanes of pavement in each direction, separated by a medial safety zone, and with easy alinement and grades. Such a facility, he said, is a super-service highway, and the fares charged are in payment for the extraordinary

features offered and not for the right of movement.

Walter A. Jones, chairman of the Pennsylvania Turnpike Commission, has proposed for immediate construction, an initial system comprising 1800 miles at an estimated cost of $860,000,000. It would comprise sections extending from Boston to Richmond, Va., Philadelphia to Pittsburgh, Pittsburgh to Chicago, Pittsburgh to St. Louis, and Chicago to Indianapolis. The Richmond-Boston section is estimated to cost $310,000,000, the extension of the present Pennsylvania Turnpike to Philadelphia, $50,000,000; the Pittsburgh-St. Louis section, $250,000,000; the Pittsburgh-Chicago section, $188,000,000, and the Chicago-Indianapolis section, $62,000,000.

The system, the speaker explained, would serve an area in which are located approximately 65 per cent of all industry, 50 per cent of the entire assessed valuation, and 40 per cent of the population of the United States. It would furnish de luxe transportation for all classes of traffic from the industrial and agricultural Middle West to the ocean ports of the Atlantic seaboard and would serve the Nation in peace or war.

New Plan for Bomber Building

(*Continued from page 69*)

This means that frequent revisions are being made in blueprints and specifications by Army Air Corps technical experts, and these alterations may affect manufacturing technique. The airframe of the Martin B-26 requires 8500 blueprints, while the bigger Consolidated B-24 lists more than 14,000 blue prints. A static test model of the B-26 fuselage, broken down into three sections for close inspection, along with wing and stabilizer, are now on display at the committee's Detroit quarters, along with several large fuselage and wing assemblies for the B-24.

The first tangible evidence of the committee's value was the placing of a $250,000 order for forging and machining of aluminum castings placed with the Eureka Vacuum Cleaner Co., of Detroit, by the Glenn L. Martin Co. Thus Martin located a source of supply that might not otherwise have been discovered because the Eureka representative visited the committee exhibit and found some parts his company could fabricate.

C. C. Carlton, director of the Automotive Committee for Air Defense, has visited several airplane plants in order to study requirements and production methods.

The plan submitted by Walter P. Reuther, director of the GM Department of the UAW-CIO, brought considerable guarded comment from automotive officials when it was submitted to President Roosevelt, Dec. 23. The President turned it over to the National Defense Commission for study. Briefly, the plan visualizes the use of excess production capacity of the automotive industry for the production of 500 fighting planes a day within six months. To attain this end it proposes appointment of a nine-man aviation production board, composed of three representatives each from management, labor and Government. This board would organize and supervise the mass production of pursuit planes in automotive plants.

The Reuther plan would necessitate the leveling off of automobile production over the entire year so that surplus capacity, estimated at 50 per cent, could be utilized for the aircraft job. It also would require delay of 1942 models six months to permit tool makers to work on the plane tooling program. In a resolution last Oct. 15, the AMA voted to subordinate work on automotive model changes to the necessities of the defense program and specifically to aviation procurement. However, GM and Chrysler as well as several other manufacturers are already at work on 1942 models although with the realization that the introduction of these cars may have to be deferred. Priorities on such raw materials as steel, aluminum or copper, or diversion of skilled labor into defense work are regarded as more serious possibilities than the conversion of automotive production machinery for aircraft use.

Speed is the essence of the Reuther plan, which proposes to make use of existing plants and machinery by adapting it to aircraft production use rather than building new plants and installing new machinery, a time-consuming process. Reuther was assisted in drawing up his plan by experienced tool and die and patternmakers who made a survey of the industry.

However, Detroit observers were inclined to believe that Reuther oversimplified the task of aircraft production. Production men estimate that less than 10 per cent of automotive production machinery can be adapted for aircraft use, while Reuther visualizes conversion of a much larger percentage. Especially in regards to engines, the Reuther plan fails to appreciate the wide difference in manufacturing technique between an aircraft and an automobile engine. Tolerances are much closer in the aircraft engine and the matter of weight per horsepower is paramount. The men who assisted Reuther in his survey undoubtedly were able workers in the field of automotive production but probably they were not conversant with aircraft manufacturing technique. Reuther used the Cadillac plant in Detroit as an example of an automotive plant that is turning out aircraft parts for Allison. However, only 30 of the several thousand Allison parts, are made by Cadillac and new machinery rather than converted machines had to be installed.

More immediate criticism of the Reuther plan was directed at the fact that it overlaps much of the work that the Automotive Committee for Air Defense has had under way with its bomber program for more than two months. The Automotive Committee undertook its program at the specific request of the Defense Commission and the Army Air Corps. The Army decided to standardize on bombers in the mass production field because there was a more urgent need for greater productive capacity for these planes to supply both Great Britain and the U. S. It also is difficult to standardize fighting planes for mass production because new developments arise every day in aerial warfare. Refinements made by the enemy must be matched or improved upon to survive. These require changes in plane production and at a productive rate of 500 per day, the obsolescence of outmoded types would be tremendous.

Another practical criticism came from an unnamed defense production official in Washington, who said the 500 plane per day rate proposed by Reuther for a total of 150,000 planes a year would require a fabulous amount of aluminum, probably 900,000,000 lb. a year, compared to present annual capacity of 400,000,000 lb. There also would be insufficient armament available for so many planes. A pursuit ship requires 18,000-man hours of labor. At 500 planes per day, 9,000,000 man-hours would be required, necessitating at least 1,000,000 workers. Semi-skilled labor in such quantities is not available, payrolls in the automobile, parts and body plants numbering 443,000 men in 1940.

The Government was appreciative of the offering by labor of a defense plan such as Reuther's in these days of urgent speed in rearmament, but defense experts were critical of its practicability.

Honed Microfinish

(*Continued from page 62*)

two operations, a total of 0.010 to 0.015 in. of stock being removed on the diameter, for clean-up from a bored finish. The final bore is accurate within 0.0005 in. and has a surface of 3 micro-inches, r.m.s.

Landing-gear retracting links have forked ends, and steel bushings for the eyes are Microfinished after assembly, as shown in Fig. 9. From 0.002 to 0.003 in. of stock on the diameter is removed in one operation, following grinding. The tolerance on roundness and straightness is 0.0005 in., and the surface finish ranges between 5 and 8

A MAN CAN STAND A PAIN BUT AN ITCH ALWAYS GETS HIM

There are quite a number of car buyers today who will insist on a different make the next time they turn in their car. A great many of these have had to contend with the failure of comparatively unimportant parts and accessories on the cars they are now driving—things that seem to be beneath the attention of your engineers. And, Mr. Car Manufacturer, there are a lot of them—control knobs coming off—windows that work down by themselves—defroster hose that won't stay connected—etc. The engineers do a fine job, but don't go far enough.

King-Seeley recognizes the danger of an itch, and is constantly on the alert to keep King-Seeley Telegages from aggravating the purchaser of your cars.

You realize that there can be a considerable difference in the voltage in the circuit supplying electrically operated dashboard gages. But Telegages are designed so that a variation as much as from 4 to 9 volts will have no detrimental effect on them. When you standardize on King-Seeley Telegages, your customers have this protection and just that much less provocation to criticize your car when they are driving it.

KING-SEELEY ELECTRIC TELEGAGES show fuel level, oil pressure and water temperature. Transmission is entirely by wire—no tubes.

KING-SEELEY CORPORATION
ANN ARBOR MICHIGAN
SUPPLIERS OF ORIGINAL AUTOMOTIVE EQUIPMENT SINCE 1922

KC TELEGAGE

micro-inches, r.m.s., the honing operation being for clean-up and to prevent fatigue failure.

Many other parts of the control mechanism of an airplane are provided with steel bushings, and these bushings are generally Microfinished after assembly, to the same degree of accuracy and with the same finish as in the case of the bushings in the landing-gear retracting links. Additional parts which are Microfinished include landing-gear oleo-strut trunnions, inboard and outboard hinge fittings, propeller-piston cylinders, propeller-bearing shaft bushings, engine-cylinder piston pins, and model-airplane-engine cylinders.

Aviation at the SAE Annual Meet

(*Continued from page* 71)

characteristic dimension of the object, and μ, the viscosity of the fluid. Reynolds numbers for modern planes are of the order of 20,000,000. In the case of a small model the characteristic dimension naturally is much smaller. The volicity of the fluid cannot be greatly increased without incurring undue expense, and the only chance of compensating for the reduced dimension is to increase the density of the fluid—by circulating air through the tunnel *under pressure*. This is done in the M.I.T. Wright Brothers wind tunnel which was described in a paper by John R. Markham, associate professor of aeronautical engineering at Massachusetts Institute of Technology.

The tunnel is of the closed-return type, with an elliptical throat of 10 by 7½ ft. and with a maximum air speed of 250 m.p.h. at atmospheric pressure. It is built sufficiently strong so it will withstand a pressure of four atmospheres and will not collapse when operating at one-quarter atmosphere. Arc-welded steel construction was used for simplicity of the joints and tightness of the seams. The propeller is located in a cylindrical section of 13 ft. diameter. It is driven by a 2000-hp. induction motor.

Balances are provided to measure the three components of the air pressure on the model, the drag, lift and side pressure, and also the three moments created, viz., the pitching moment, the rolling moment and the yawing moment. The scales will measure up to 3000 lb. lift, 600 lb. drag and 350 lb. side force, while the maximum moments that can be measured are 400 lb.-ft. pitching, 350 lb.-ft. rolling and 300 lb.-ft. yawing.

With this wind tunnel and balance system it is possible to obtain measurements very rapidly on a complete airplane model from which the coefficients for all six components can be plotted with a minimum of calculation. It is usually possible to mount the model so that the point representing the center of gravity of the airplane is on the balance axis, a feature which increases the accuracy of the results and the simplicity of the calculations.

IN APPLYING a finish to the cylinders of air-cooled aircraft engines, the primary object usually is to prevent corrosion, but the effect of the finish on the rate of radiation also is of importance. Dr. Myron A. Coler, technical director, Engineering Products Division, Paragon Paint & Varnish Corp., described some experiments made to determine the effect of various coatings on the rate of heat radiation from metal surfaces. Experiments were made, not with actual engine cylinders, but with standard size cylindrical metal shell (without top or bottom) which was mounted vertically over the open electric heater and sealer with a cover carrying a dial thermometer and thermoregulator. The thermoregulator was adjusted to maintain a desired nominal internal temperature as measured by the thermometer. When equilibrium was established, the time to dissipate a definite amount of energy, as measured by the watt-hour meter and a synchronized electric clock, was noted. The metal shell was then removed and coated and the procedure repeated. Surface temperatures were measured by means of thermo-couples and a potentiometer pyrometer.

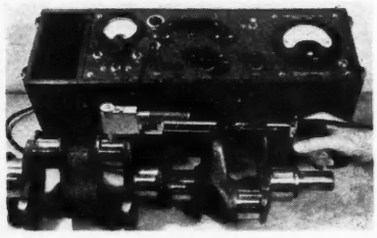
MORE and more manufacturers are showing numerical roughness ratings on their blueprints. In their own operations *and in the production of their suppliers* they expect strict adherence to these surface roughness specifications.

The Profilometer is the *shop* instrument which permits quick, accurate and progressive checking of any "finish" during machining operations. When it is used, the time required to secure desired finishes is reduced to a minimum. The chance of error and possibility of parts rejection due to improper surface roughness is eliminated. Wherever it is now in use, the Profilometer has proved that it pays for itself within a very short time.

EASY TO USE

In order to secure a reading, it is only necessary for the operator to move the tracer across the surface for which the roughness is to be determined. This surface may be of almost any size or shape. The meter gives direct readings in true inch units . . . exact information concerning the finish that is being secured—at the time it is most useful. No computations or scaling methods are required.

WRITE FOR FULL INFORMATION.



The PROFILOMETER

PHYSICISTS RESEARCH COMPANY

343 SOUTH MAIN ST. • ANN ARBOR, MICH.

An example of economy with serviceability by standardizing on Molybdenum steels: a manufacturer of speed reducing equipment uses Chromium-Molybdenum, SAE 4140, for gears and SAE 4150 for pinions.

Treated to 24-28 and 28-34 Rockwell "C" respectively, these two readily available, low cost and easily machinable steels comfortably meet the toughness and hardness requirements of the service.

Write for your copy of our free technical book, "Molybdenum in Steel".

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • CALCIUM MOLYBDATE

Climax Mo-ly-b-den-um Company
500 Fifth Avenue · New York City

MOLY

The cooling efficiency of the coating was defined as the cooling rate with the coated surface divided by the cooling rate with the uncoated surface. For a series of enamels based on the same vehicle the cooling efficiencies varied from 1.13 for the clear enamel down to 1.07 for the black enamel containing carbon black. Intermediate values were 1.12 for white enamel (titanium dioxide), 1.09 for red (iron oxide), 1.09 for green (chromium oxide), and 1.08 for aluminum (standard varnish grade).

From the results the conclusion was drawn that certain enamels will improve the cooling characteristics of aircraft-engine cylinders. An enamel for this purpose, however, must also fit nicely into high-speed production schedules. The author said self-priming cylinder enamels are now available which can be used directly for both priming and finishing coats on all of the aluminum and ferrous alloys of which modern cylinder heads and barrels are constructed. They also form excellent adherent coats over a number of standard primers such as the Navy Aeronautical Specification P27z Zinc Chromate Primer. These enamels have unusual heat, water, oil and gasoline resistance. Although they are not sensitive to even severe over-baking, they may, nevertheless, be cured rapidly at temperatures of 350 deg. F. and lower. They may be readily brushed, sprayed or dipped, an hence are particularly suitable for production line work.

Radio control is measured in seconds, but the timing of today's high-compression automotive engine is measured in the infinitesimal fraction of a second. Smoothness, quietness and long life are also important timing chain factors. It is significant, therefore, that a large majority of all chain-equipped cars are equipped with Morse Silent Timing Chains.

MORSE CHAIN COMPANY
ITHACA, N. Y. DETROIT, MICH.
Division, Borg-Warner Corporation

MORSE
SILENT TIMING CHAINS

Plastics In Aircraft

(*Continued from page* 67)

applied over stiffening members, such as ribs and other structural elements after each joint has been saturated with resin. Whether the stiffening members, be they ribs, spars or other framework, undergo a similar molding operation is not stated, but they are built up from laminations using the resin as a binder, presumably the same resin employed in the shell or skin portions.

When the assemblies of the large components, including wings, fuselage and control surfaces, are complete, they are wheeled, while still on jigs, into an oven 40 ft. long and 10 x 10 ft. in section (large enough to take the major components of a fairly large plane, all at one time). There they are baked "for several hours" at a temperature of 180 deg. F., the temperature and the humidity being subject to careful control. Baking presumably completes the curing and hardening of the resin and forms each major element into a rigid and well bonded structure. After baking is completed, the major parts are assembled, the engine, landing gear and other metal components are put in place, and the assembly is made ready for finishing. The latter includes several coats of "plastic" paint which is rubbed to "glass-like smoothness." When instruments, controls and equipment have been installed, the plane is ready for test.

Information furnished does not state how the pressure required in the molding process is applied, but a rubber blanket or bag or their equivalent is understood to be used and the mold is kept "warm," hence steam or air pressure probably is used. In what are described as "production models," there are reported to be two gasoline tanks formed in the wing sections, treated with special compound and lined with neoprene. This is said to result in considerable saving in weight. Flight tests of a "prototype" plane are reported in progress as this is written. "Initial production" is said to be started and "substantial" production is anticipated in February.

Some particulars concerning the Bellanca process were given in a recent engineering paper by H. N. Haut, Chief Inspector of Bellanca Aircraft Corp., but they do not include details as to the molding process. It is reported, however, that molding is done under mechanical pressure applied by clamping the laminations, after they are coated with resin, between forms which, in effect, constitute molds. Clamps are said to be of the screw-operated type,

similar to those used in gluing operations. In other respects, the procedure is understood to involve applying the resin employed in a water solution to which is added an accelerator which gives the phenolic resin cold setting properties and hastens the cure when heat is applied subsequently. Plies of veneer are placed in the mold and are coated, either by spraying or by brushing, with the solution.

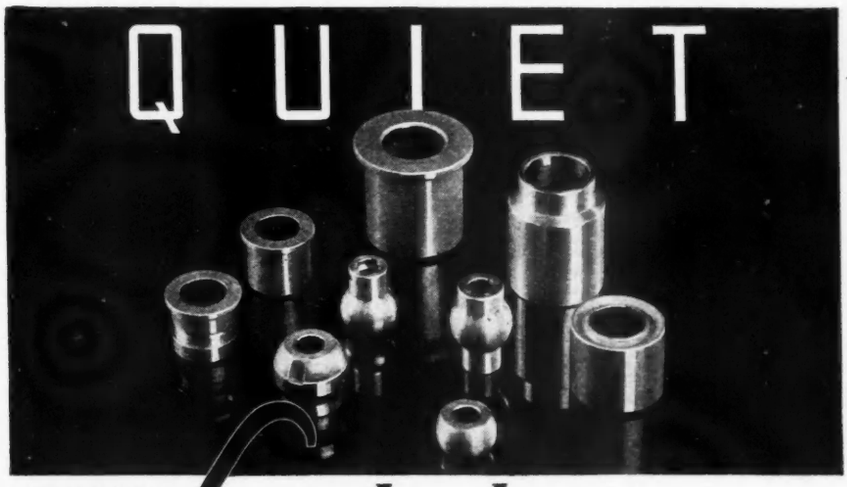
Of particular significance is the use of special ingredients (the resin and the accelerator), developed by Catalin Corp., having such properties that curing can be done at the unusually low temperature, for a phenolic material, of 140 deg. Fahr. This temperature is sufficiently low to be readily maintained in large rooms or ovens without supplying nearly so much heat or using so much insulation as is required for baking at much higher temperatures. In addition, humidity, said to be favorable to the structure of the wood, is readily maintained.

It is understood that the resin, with the accelerator used, will set at ordinary room temperature in about 24 hours. Curing, however, is completed in the mold. The time required for curing at 140 deg. Fahr. is said to be from 2 to 6 hours. Mixing, handling, spreading and clamping properties are said to be almost identical with those of casein glue, but much stronger joints are secured and, unlike casein, exposure to moisture and weathering does not result in significant deterioration. The method and materials named are reported approved for use in production by the Civil Aeronautic Authority and the U. S. Army. Planes are being built with this type of structure for the U. S. Air Corps in the National defense program but decriptions of them are not permitted at present. According to one report, resin solutions of similar formulation have been tried with success in the Vidal process, one of the advantages gained being that rubber bags employed remain serviceable for much longer periods at the 140 deg. Fahr. temperature than at the higher temperatures required with other types of plastic bonding materials.

Glenn L. Martin Company is known to have followed closely developments involving the use of plastics for aircraft fabrication and has established a fellowship at the Mellon Institute for reasearch along this line. It is also making some use, either in its own plant or through suppliers, of plastic in fabricating parts for aircraft which it turns out, although the craft themselves are, at present, primarily metal products. In response to inquiries concerning the fabrication of the door for a bomb bay in one of the Martin planes (the door which was illustrated in AUTOMOTIVE INDUSTRIES for Nov. 15, page 546), the following particulars were furnished:

The doors in question are essentially hollow boxes having plywood covers and poplar framing. They each weigh approximately 50 lb. total without metal fittings, of which total the plywood covers weigh 26 lb. The latter are made from ⅛-in. plywood having mahogany faces and poplar cores bonded with hot setting phenol formaldehyde adhesives. Ribs are made from 15 laminations of ⅛-in. poplar, glued with cold setting urea formaldehyde adhesive and bowed to the shape of the door while the glue is still wet. The ribs retain their bowed shape when the glue sets. End ribs are made in the same manner except that ash veneer is used instead of poplar. Longitudinal rails are of poplar except for the hinge rail which is laminated ash. All clear, first-quality, straight grained veneers are employed. Whether metal molds are used in fabricating and how pressure and heat are applied is not stated. The doors are 14 ft. in length.

From the foregoing it will be apparent that considerable progress is being made in the use of plastics for fabricating large structural parts of aircraft. In a subsequent article it is proposed to give some particulars as to the properties of plastic bonded parts made in the manner indicated and to say something as to their advantages and about the performance of the planes in which they are used.



JOHNSON Ledaloyl SELF LUBRICATING

BEARING BRONZE

● Do you want to eliminate noise in your bearing applications? Then try LEDALOYL.

Our exclusive process of PRE-ALLOYING the basic metals prevents the formation of harmful oxides . . . assures uniform structure throughout the bearing. Likewise, it permits the introduction of lead which provides quick, easy conformability and prevents galling or freezing to the shaft. Add to this the fact that LEDALOYL contains oil . . . up to 35% by volume . . . and you realize why LEDALOYL operates so *quietly*, so efficiently and for such a long period of time.

LEDALOYL is the only self-lubricating bearing with *controlled lubrication*. Millions of pores, evenly spaced, provide pin-point lubrication to the entire bearing area. The minute size of the pores *meters* the lubricant in the exact amount required for efficient operation at all speeds and loads. Likewise, the bearing absorbs the oil when the shaft is at rest. Thus you have the right amount of oil . . . in the right place . . . at the right time.

Why not try LEDALOYL on your next application. Test it in comparison to any bearing you have ever used. Compare the operating record . . . the operating temperature . . . the life and the load carrying capacity. Convince yourself that LEDALOYL is the ideal self-lubricating bearing. Your inquiry carries no obligation.

Carried in Stock

LEDALOYL is now available from stocks conveniently located in principal industrial centers. Write for a copy of our latest catalogue listing sizes, prices and the location of your nearest source of supply.

JOHNSON BRONZE

Sleeve BEARING HEADQUARTERS

625 S. MILL STREET · NEW CASTLE, PA.

Why do it the

★

For prompt action call the nearest Carnegie-Illinois office.